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WIRE DRAWING

METHODS AND MACHINES USED BY THE DRIVER-HARRIS WIRE CO.

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THE making or drawing of wire of small diameter has, for centuries past, formed an industry by itself. As the methods used in this industry are comparatively unknown to the average mechanic, a description of them and of the machines used will probably be of interest. On account of the fact that wire drawing is a very old art, many of the methods used have been handed down from generations. Improved machinery, however, has been introduced, and the rapidity and accuracy by which the wire can be produced has been greatly increased during recent years.

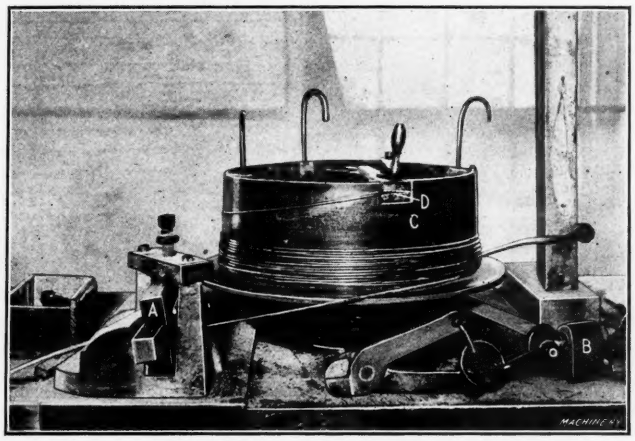

Fig. 1. A Typical Wire Drawing Machine for Heavy Wire

The earliest mention of wire drawing is in an historical document which shows that in 1351 there were men engaged in this work in Augsburg in Germany, and it is believed that the art was originated by a man named Rudolph, from Nuremberg, about that time. It is definitely known that in 1370 there was a wire drawing mill in the latter city making wire from a number of different metals. From Germany the art of wire drawing was introduced into England in the seventeenth century. The first wire drawing mill in America was built in 1775 in Norwich, Conn., by Nathaniel Niles, who was granted a loan of $1500 by the court for this purpose. Previous to the development of wire drawing, wire was made by hammering or beating metal into thin sheets or plates, which were cut into continuous strips. These strips were then afterwards rounded by hammering.

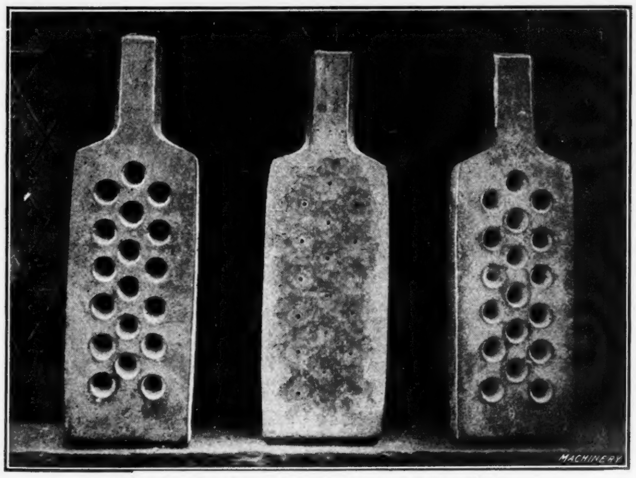

Fig 2. Front and Rear Views of Draw Plates

Modern Wire Drawing Machines

The machines illustrated in connection with the present article, and the methods described, are those used by the Driver-Harris Wire Co., Harrison, N. J. This company manufactures high-class wire, mainly for electrical purposes, the wire being drawn from nickel-steel and nickel-chromium alloys, copper and nickel alloys, copper and brass. The methods employed for drawing wire of different materials must be varied to suit the metal or alloy being drawn, and, therefore, a number of different types of wire drawing machines are employed. The diameter to which the wire is drawn also has an influence on the choice of method used. The special qualities required of the wire used for electrical instrument work, especially electrical heating devices, pyrometers, etc., are that it shall have a high resistance and a high melting point. This is the reason for the use of the many special alloys mentioned.

In describing the methods used, three main divisions or classes of wire may be distinguished, and the special machines and methods used for each class will be illustrated and described. The first class comprises iron and nickel, and nickel and copper alloy wire drawn to a diameter of from No. 3 to No. 18 Brown & Sharpe wire gage (from 0.229 to 0.040 inch in diameter). The second class comprises wire of the same materials from No. 18 Brown & Sharpe gage (0.040 inch) down to 0.002 inch in diameter. The third class comprises brass and copper wire in sizes from 1/4 inch in diameter down. In addition, flat wire is manufactured. This is first drawn round, however, to a given diameter, and is then merely flattened out between ground rollers.

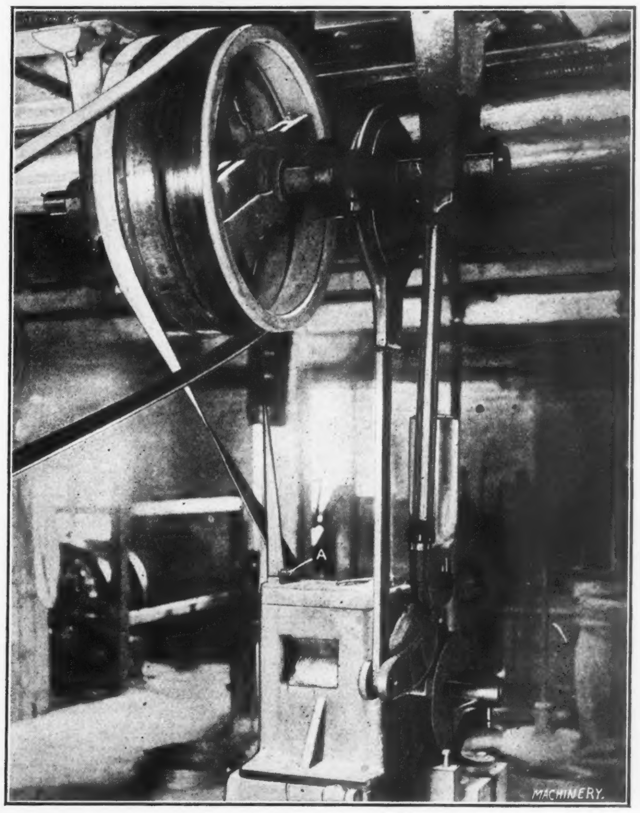

Fig. 3. A Wire Pointing Machine

Drawn Wire made from Nickel Steel, Nickel-Chromium, and Nickel and Copper Alloys

The wire from which the finer sizes are drawn is about 1/4 inch in diameter. It is rolled to this dimension in the wire rolling mill connected with the wire drawing mill, and is wound up into coils suitable to be put onto the reels used in connection with the wire drawing machines. In the rolling mill department the various alloys are melted, cast into ingots, hammered and rolled out, in much the same way as is ordi-

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nary drill-rod or tool-steel wire. (A description of the methods used for this work was published in MACHINERY, in the November, 1909, number, in an article entitled "The Making of Tool Steel").

After having been received from the rolling mill, wire of the size and material constituting the first class mentioned in the foregoing, is drawn in wire benches or machines of the type shown in Fig. 1. Before the drawing commences, the wire must be pointed so that the operator can push the end of it through the draw plate, this plate being provided with holes through which the wire is pulled in order to reduce its diameter. The pointing is done in the machine shown in Fig. 3, which is provided with two rollers, oscillated back and forth by means of the lever shown on the right-hand side of

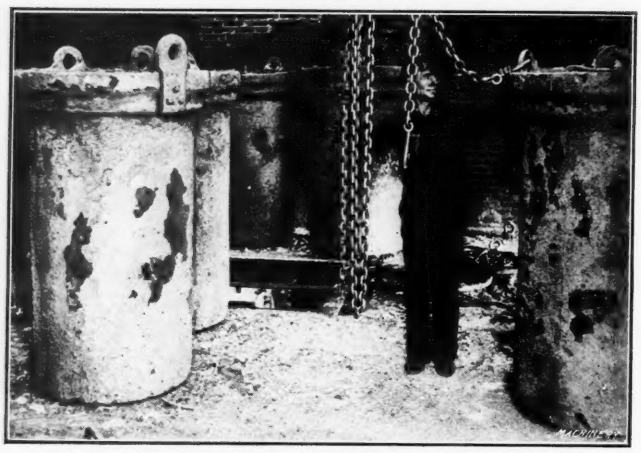


Fig. 4. A Number of Large Annealing Pots used in Wire Mill

the machine, and the eccentric mounted on the countershaft near the ceiling. The rollers are provided with a number of grooves in their faces, the grooves of the two rollers meshing with each other and the diameters of the grooves decreasing successively from one end of the roller to the other. The upper roller can be raised and lowered by manipulating a handle at A. By pushing the wire into a number of successive grooves, the operator obtains a point for starting it through the draw plate.

Referring to Fig. 1, the wire is pushed, by hand, through the hole in the draw plate A, which is of the correct diameter to which the wire is to be reduced. It is then pulled through by power for a distance of about 24 to 30 inches by means of an arm B provided with a tong or grip jaws at its end, and operated by a cam on the vertical shaft of the machine upon which pulley C is mounted. As soon as a sufficient portion of the wire has thus been pulled through to permit it to be attached to the pulley or block upon which the drawn wire is wound, the end of the wire is clamped between jaws D, as shown, and the block is set in motion by a foot treadle, which permits it to engage a clutch, thus connecting it to the driving mechanism beneath the wire bench. This driving mechanism consists of a longitudinal shaft which drives a number of blocks by means of spur and bevel gearing.

The blocks are driven at different speeds according to the diameter of the wire being drawn and the characteristics of the alloys used. A general idea of the speeds allowable may be had from the fact that iron and brass may be drawn at velocities varying from 12 to 45 inches per second. Wire of less tensile strength must, of course, be drawn at a slower speed than that of a higher tensile strength. On the other hand, more ductile wire can be drawn at a much higher speed than that which is less ductile. One of the important considerations in wire drawing is that a line passing at right angles through the center of the hole in the draw plate through which the wire is drawn, and at right angles to the face of the plate, should be tangent to the pulley or block upon which the wire is wound; otherwise, the wire is liable to become kinky and will not be of a uniform structure throughout its cross-section.

When drawing, the wire is pulled off from a reel on which the coil is laid previous to drawing, and is reeled off as the drawing proceeds. These reels are not shown in Fig. 1, but one of them can be seen to the left in Fig. 6. Before the wire goes through the draw plate, it passes through a container holding the lubricant. Grease, soap water or pulverized soap are used for lubricating the wire, according to the material being drawn. Music wire, the characteristic of which is that it possesses exceedingly high tensile strength, must be drawn wet or very thoroughly lubricated, and, in this case, the reels with the wire are set into tubs containing the lubricating solution of soap water and are reeled off from the submerged reels and immediately drawn through the draw plate. At first thought it might seem that the same result would be obtained by flooding the wire in soap solution immediately before it enters into the hole in the die. Undoubtedly the same effect would be obtained in this manner, but the method of submerging the coils in a tub containing the lubricating solution has been found simpler, as in this way pumping arrangements, piping and pans for taking care of the lubrication become unnecessary.

The draw plates, three of which are shown in Fig. 2, are made of a high-grade tungsten steel into which usually eighteen holes of different sizes are drilled and reamed. These holes taper, having the correct diameter of the wire to be drawn at that face of the plate which is towards the block or pulley. The draw plate in the center shows the face, while those at the sides show the back of the plate with the tapered hole where the wire enters. The draw plates are furnished already drilled and reamed by the steel makers, and the only work required to be done on these plates in the wire drawing mill is to keep the holes to size. This is done by heating the plates and hammering them so as to reduce the diameter of the holes. After the plates have been hammered the holes are reamed out by small hand reamers, the size being gaged by drawing a wire through the hole and measuring it by micrometers. The diameter of the wire drawn is also measured by micrometers after each time it has been passed through the draw plates, in order to guard against inaccuracies due to the wear of the holes in the plates. These holes wear very rapidly, and it is, therefore, necessary to keep constant watch as to their performance.

The wire is reduced in diameter at each drawing or pass by one number or step in the Brown & Sharpe wire gage scale. This wire gage, which was compiled in 1864 by Messrs. Brown & Sharpe, is not entirely arbitrary, as one might think after a casual inspection of the wire diameters of the various sizes, but the diameters of the wires of successive numbers increase

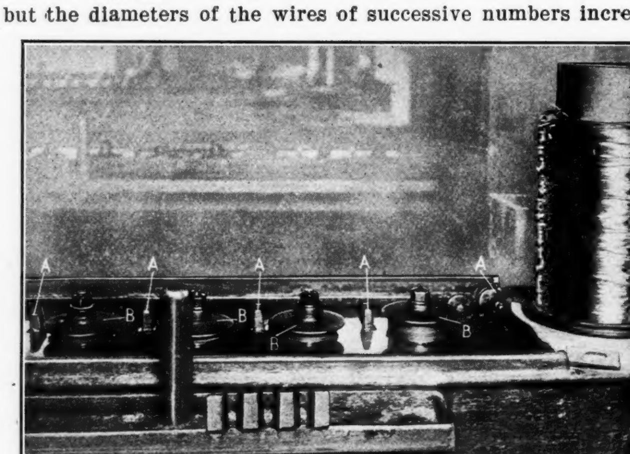


Fig. 5. Part of a Continuous Wire Drawing Machine for Finer Sizes of Wire

according to a geometrical ratio. For example, the step between Nos. 17 and 18 B. & S. gage is about 0.005 inch, while the step between Nos. 8 and 9 is about 0.014 inch. The ratio of the diameter of No. 8 to No. 9 is the same, however, as the ratio of No. 17 to No. 18. Each succeeding number can be found by multiplying the preceding number by 1.123, this being the constant factor of the geometrical ratio on which the Brown & Sharpe wire gage system is based. The basic size is No. 36 wire, which is 0.005 inch in diameter.

The drawn wire wound up on the block of the wire drawing machine requires to be annealed either between each pass, as in the case of certain materials, or between, perhaps, only every fifth or sixth pass, as in the case of other alloys. For the annealing process the wire is packed in large cast-iron

pots about three feet in diameter and six feet high, some of these pots being shown in Fig. 4. Four furnaces are provided, each capable of holding one of these pots, the pots being lowered down into the furnace in a vertical direction. The temperature of the furnace is gaged by means of pyrometers. The pots containing the wire coils are heated for about ten hours and are then permitted to cool for about twenty-four hours. According to the material being annealed, the wire is either put in the pots without any packing at all, or, in other cases, packing of charcoal, sand or lime is used. After the annealing pots have cooled off and the wire coils have been taken out of them the coils are pickled by being dipped in tanks containing diluted sulphuric or hydrochloric acid. This acid is then dried off by drying the wire coils in an oven

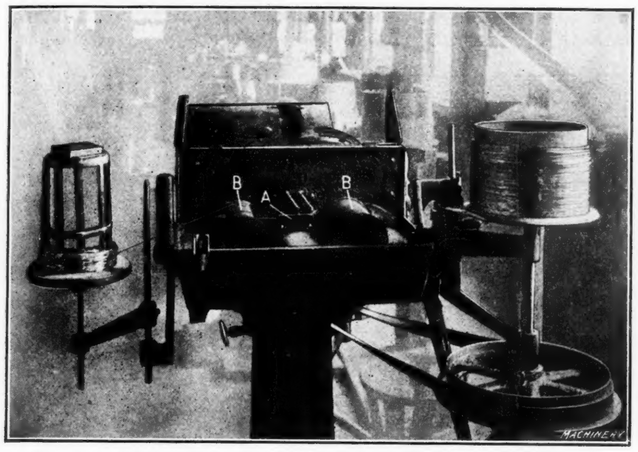


Fig. 6. Another Continuous Wire Drawing Machine for Fine Wire

heated by means of steam coils to a temperature of about 220 degrees F.

Drawing Fine Sizes of Wire

The finer sizes of iron, nickel and chromium alloy wire—those between 0.040 and 0.002 inch in diameter—are drawn through a succession of dies at one operation. These finer sizes are pointed either by merely pulling the wire apart by hand or by filing the end. Part of one of the machines used for drawing wire down to 0.010 inch in diameter is shown in Fig. 5. The wire is reeled off from a reel at the left, which is not shown in the illustration, and then passes successively through the dies shown at *A*. After the wire has passed through one die it passes around a pulley *B*, mounted on a vertical shaft, and then through the next die, and so on until it has gone through the required number of successive dies. The maximum number of dies provided in this machine is ten, of which only five are shown. To the right is shown the block or drum upon which the drawn wire is coiled.

Each die reduces the diameter of the wire one number in the Brown & Sharpe wire gage scale. The various pulleys *B* are geared to the proper speed for the diameter and speed of the wire at the time it passes around each respective pulley. It is evident that as the wire travels through die after die and is gradually reduced in diameter, the speed at which the wire passes around the pulleys and through the next die increases. As the Brown & Sharpe gage numbers decrease according to a geometrical ratio, the speeds of the pulleys are also in a geometrical ratio, increasing with the decreasing diameter of the wire. In designing the machine, it is assumed to be preferable to have the pulleys run a trifle too slow rather than too fast, in order to prevent the wire from coiling up in front of the die it is to pass through. If the speed is a trifle too slow there will be merely a pull on the wire which, within limits, has no detrimental effect. The rollers and dies are all immersed in a soap solution for which the machine bed itself forms a trough, as shown, so that the wire is thoroughly lubricated while being drawn.

Sizes finer than 0.010 inch are drawn in machines of the type shown in Fig. 6. In these machines the dies are all placed in the central bracket *A*, while the wire is wound back and forth over drums *B*. The reel from which the wire is being wound off is shown at the left, and the block on which it is wound after having passed from the last drawing die is shown to the right. Block *A* contains twelve dies, and the drums *B* are grooved so that the wire is wound around them from the back towards the front, passing through a die each time it passes on the upper side from the left to the right drum. In this case the wire is reduced, for each pass, only one-half of a number in the Brown & Sharpe wire gage scale. As the wire between the various passes runs over drums rotating at a uniform speed, the increase in speed of the wire as it is reduced in diameter must be taken care of by the slipping of the wire over the drums. At first sight it might seem that this would cause difficulties, but practical experience shows that this method is perfectly feasible. The drums and the dies are immersed in soap solution the same as in the case of the machine shown in Fig. 5. While twelve dies are provided in this case, it is evident, of course, that when the reduction to be made is less than that for which all the twelve dies would be required, only the number of dies that corresponds to the required reduction is used. After the wire has been drawn, it is annealed as already mentioned in the case of wire of larger diameter.

Diamond Dies

The dies used for the drawing of the finer wire are so-called diamond dies, a number of these being shown in Fig. 8. These dies consist of a body made from brass into which is counterbored a hole of about ½ inch diameter. A small hole for the wire is drilled clear through the brass body. The counterbored hole in the body constitutes a seat for the diamond which is set in the center of the hole with molten brass or solder poured in around it until the hole is filled.

A view of the diamond die drilling department is shown in Fig. 7. The machines shown in the foreground are for recutting or enlarging the holes in dies which are worn, while the machines in the background are used for cutting or drilling the holes in new diamonds.

When a diamond die is to be made, the diamond (of the variety known as bort) is first prepared in a regular bench lathe. The diamond or "stone," as it is ordinarily termed in the shop, is held to a small faceplate in the bench lathe by diamond cement. It is then flattened on two sides by means of another stone held in a pair of pliers. The stone is then cupped or centered (also by the use of another stone) to provide a starting point for the diamond drill, by means of which a fine hole is drilled with the drilling machine shown in the background of Fig. 7. The stone is held in this machine

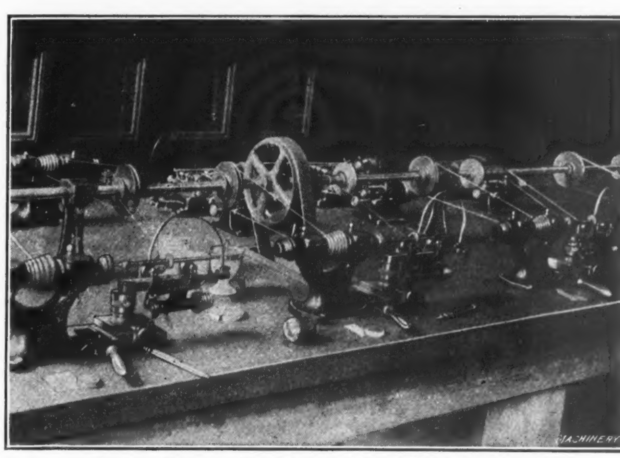


Fig. 7. Some of the Diamond Die Drilling Machines

on the flat end of the spindle with diamond cement. The drill used for the hole is made from an ordinary sewing needle ground on the end by hand to the correct diameter. This needle, the end of which is supplied with diamond dust and oil, is put into a rotating spindle in the machine and revolves at a speed of about 2000 revolutions per minute. The stone itself does not revolve, but merely oscillates back and forth towards the needle, the oscillation being produced by a cam. Provisions are made for increasing or decreasing these oscillations, and for feeding the stone forwards towards the needle as the hole is being drilled through. Ordinarily, about ten hours is required for piercing an average stone. The hole in the stone is gaged by drawing a wire through it and measuring the wire with a special micrometer, graduated so as to

read directly to 0.0001 inch, and on which it is easy to estimate one-half of a ten-thousandth of an inch on account of the size of the graduations.

After the hole has been drilled through to the proper diameter it must be tapered at the back end, much the same as the holes in the large draw blocks in Fig. 3 are tapered. The taper in the stones is produced by grinding the needle to a taper and using the same machine with diamond dust and oil as before. After the stone has been drilled, tapered and properly gaged, it is placed in the holder. While pouring

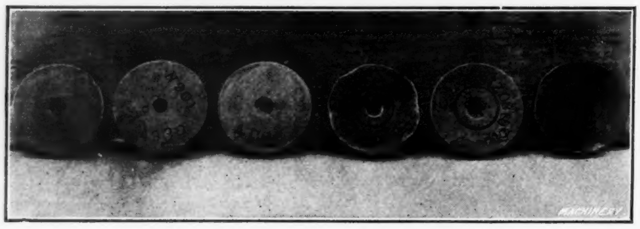


Fig. 8. A Collection of Diamond Dies

the molten brass into the counterbored hole in the holder the stone is held in place with a center in a small machine similar to a bench drill press.

After having thus secured the stone in the die, the die-holder is faced off in a bench lathe, and the proper setting of the diamond in the die is tested by placing the die on a needle of the correct diameter for the hole in the diamond. If the die "balances" perfectly on the needle it indicates that the diamond is properly set into the body. It is important that a die be set with its axis accurately at right angles to the face of the brass disk or body, as, otherwise the wire drawn through it will not be straight. Should the die show a tendency to stand off at an angle when pushed onto the testing needle, this would indicate that the hole in the diamond was

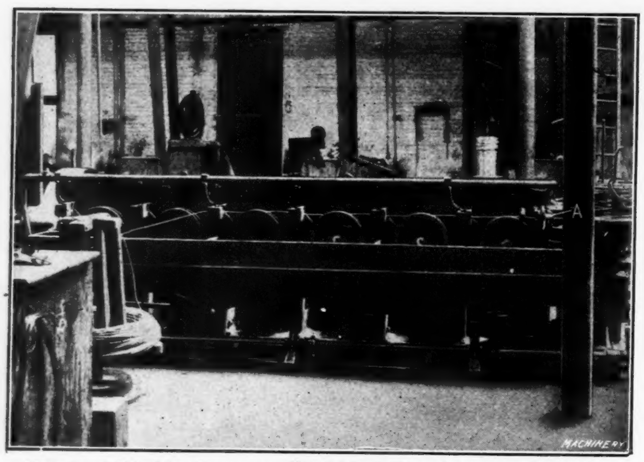


Fig. 9. A Machine known as "Bull-block," used for Heavy Sizes of Copper and Brass Wire

not set squarely with the face of the die. To the observer, the method of making a diamond die is apparently simple, but it requires a great deal of skill and patience.

A record is kept of the performance of all dies, showing the material on which they are used and the length of time that the hole remains true to size. When the dies are found to be worn they are sent back to the diemaker, who first tests them for size and examines them under a microscope to determine the condition of the die. Sometimes the dies crack after having been used for some time, in which case they are either used for smaller dies or are crushed to provide the diamond dust by the aid of which the holes in the dies are drilled and enlarged. Those dies which upon their return are found to be perfect, except that they have worn so that they cannot be used for the size to which they were originally cut, are enlarged so as to be used for the next larger size of wire.

The recutting is done in the recutting lathes shown in the foreground in Fig. 7. In this case the die is held with wax onto the faceplate of the spindle of the machine and is revolved at about 1800 revolutions per minute. The needle which enlarges the hole is not revolved in this case, but is oscillated in the longitudinal direction by a cam and by the spring shown bent over the tailstock end of the machine. The stones vary in hardness, and while the average time for enlarging a hole 0.001 inch in diameter is about one and one-half hours, in many cases it happens that ten or twelve hours is required for removing a single thousandth of an inch. In this department there are thirteen recutting lathes and three machines for cutting new diamond dies constantly in operation, and the diemaker must keep a careful record of the conditions under which each machine operates, so that he can stop a machine and test his die at the right time. The machines are all driven from a shaft running through the center of the table, as shown, this shaft being driven from a motor underneath the bench.

Brass and Copper Wire

Brass and copper wire is drawn more easily than are the larger sizes of alloy wire, and can, therefore, be drawn, for all sizes, in machines having a number of successive dies. The

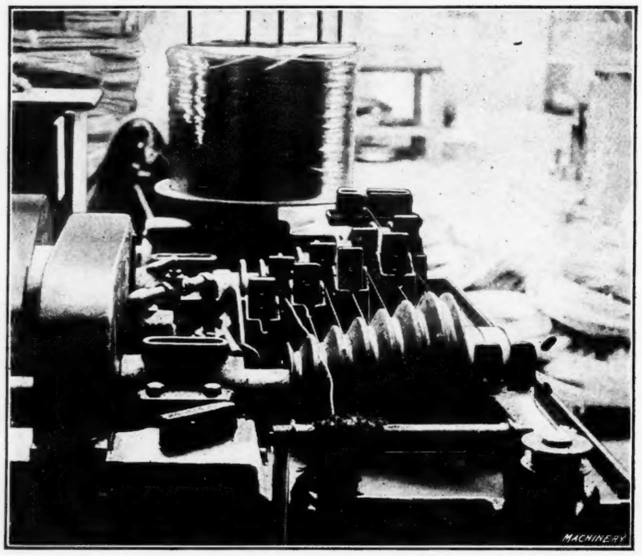


Fig. 10. Another Type of Wire Drawing Machine used for Copper and Brass Wire

machine shown in Fig. 9 is called a "bull block," and is used for drawing brass and copper wire in sizes between 1/8 and 1/4 inch in diameter. This machine has a capacity for seven dies, although, of course, the number of dies being used at any one time is determined by the required reduction of the wire. In the illustration five dies are used. Each pass reduces the wire one number on the Brown & Sharpe wire gage scale. The reel on which the coil of wire being drawn is held, is shown to the left, and at the extreme right is shown the block onto which the drawn wire is wound. The last die at *A* revolves

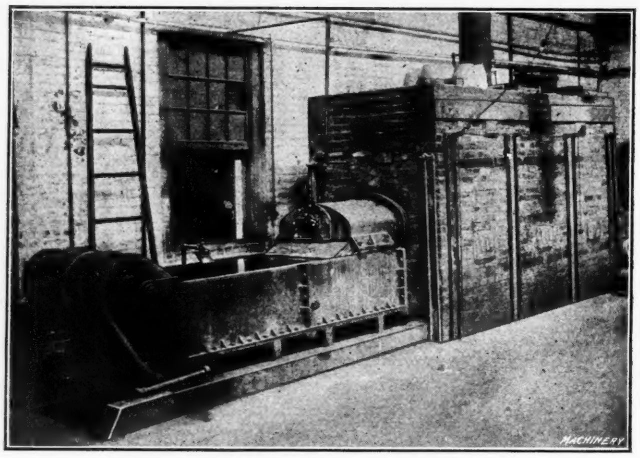


Fig. 11. Annealing Furnace for Copper Wire

about the wire being drawn in order to produce a smoother surface. The dies proper are made of rectangular blocks of chilled cast iron. The wire passes through the dies and around the pulleys shown between each pair of dies in a manner similar to that described for the machine shown in Fig. 5. The lower half of the pulley is immersed in lubricating solution, the bed of the machine forming a trough for this. The wire is threaded through the various dies by a special machine by means of which it is pulled through each die an amount

sufficient to wind it around the pulleys once or twice before starting the operation.

Another machine used for drawing copper wire is shown in Fig. 10. This machine is constructed somewhat on the same principle as that shown in Fig. 6, except that the drums over which the wire passes between each pass through the dies are not cylindrical, but conical in shape. This takes care of the increasing velocity with which the wire travels as it is reduced in diameter. It passes over the smallest diameter pulley when it is large in diameter and successively mounts the higher steps as it is reduced in size, until it finally is wound onto the block or drum shown in the background.

An interesting method is used for annealing brass and copper wire. The heat for annealing this wire need not be as high as that for annealing the alloy wire, and, hence, a different furnace is used. This furnace is shown in Fig. 11, the furnace proper being shown towards the right, it having an extension in the right-hand direction similar to that shown on the left-hand end in the illustration. The coils of wire are placed on an endless chain which moves from the left to the right. This chain is shown in the illustration passing over rollers at the extreme left-hand end. The furnace proper is in the center and the extensions at the ends are tanks filled with water which serves as a water seal, preventing the air from

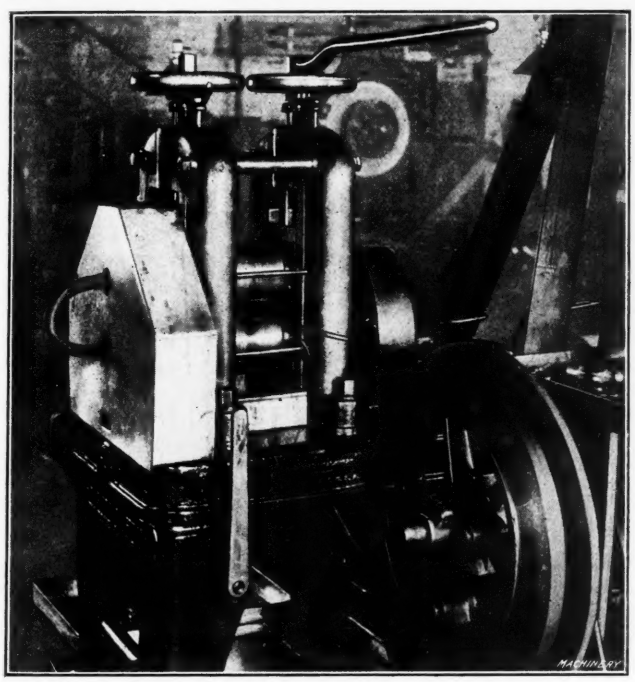


Fig. 12. Machine for Rolling Flat Wire

entering the furnace, thus avoiding oxidation and insuring uniformity in temperature.

The furnace is fired with soft coal, but the gases of combustion do not come into contact with the material being annealed. The endless chain moves slowly, carrying the coils down through the water tanks and up into the furnace, the speed of the chain being so timed that the coils remain in the furnace for a certain length of time to heat them to the required temperature. The speed of the chain can be regulated so that the coils of wire will remain from one to five hours in the furnace. The coils pass out of the furnace at the right-hand side through a water tank similar to that shown at the left-hand end and are removed as they reach the right-hand end.

Making Flat Wire

The flat wire, as already mentioned, is produced from drawn, round wire of the required diameter. One of the machines used for flattening the wire is shown in Fig. 12. The machine consists principally of two hardened steel rollers, the upper one of which is adjustable for height. These rollers are carefully ground, and as the round wire is passed between them it is gradually flattened out to the required thickness in a series of successive passes between the rollers. The rollers must be very hard and are not tempered after hardening. They are imported, being made of a special alloy steel, and the cost of a pair of these rollers may be as high as $300 or $400. It is highly important that they be of uniform hardness throughout, as otherwise they would wear more on one side than on the other and produce a wire which would not be uniform in thickness.

The diameter of the round wire to be used for a given size of flat wire is determined by experiments, and these experiments must be repeated for wires of different materials, as some materials cannot be successfully flattened to the same degree as others. On the side of the machine from which

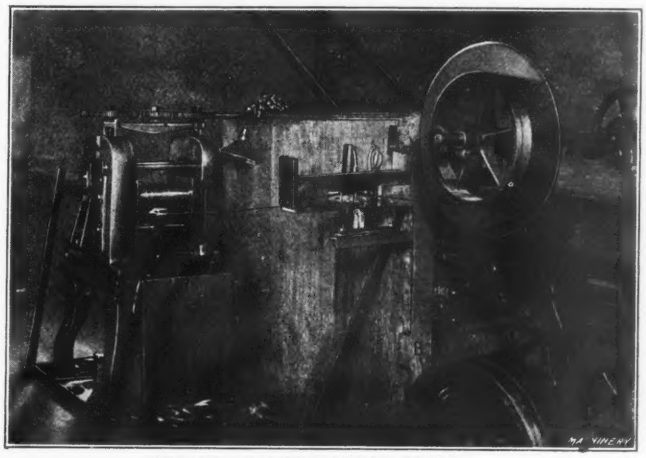


Fig. 13. Flat Wire Slitting Machine

the wire passes in between the rollers there is a clamping device which provides the proper tension for the wire, so that it is fed in under tension. On the side where the wire passes out from between the rollers, as shown in the illustration, a large wheel is placed, onto which the flat wire is wound up as it comes from the machine.

When very wide, flat wire is to be made, uniformity of width cannot be obtained by a mere rolling process, but it is necessary to slit or trim off the sides of the wire to a uniform width after rolling. Should an attempt be made to flatten the wire, say in a grooved roller, so as to insure thickness and width at the same time, the rollers for this purpose would be so expensive that the method would not be commercially useful. Slitting machines, such as shown in Fig. 13, are, therefore, used for cutting the wire to a uniform width. These machines consist mainly of three steel disks, two on the lower shaft and one on the upper. The upper disk trims the wire between the two lower disks. Very wide, flat wire can be

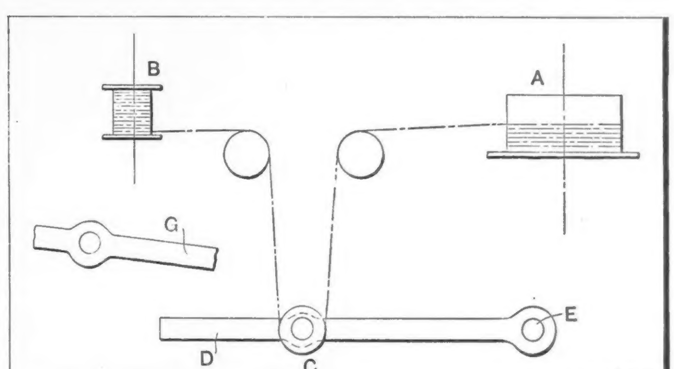


Fig. 14. Diagrammatical Sketch of an Ingenious Safety Trip

slit into several uniform widths at a time, if required. The sizes of flat wire that can be rolled in the manner described vary from 2½ inches wide by 0.020 inch thick down to 1/64 inch wide by 0.002 inch thick. Flat wire 1 inch wide can be rolled as thin as 0.003 inch thick by this method.

When the wire is slit, the band of flat wire that has been cut to the correct width is wound up on a block or drum, as shown at *A* in Fig. 13. It is also necessary, however, to take care of the scrap cut off, as otherwise this would be likely to cause trouble. The scrap wire is, therefore, wound up on the lower drum shown at *B*, these drums being geared to the proper speed so as to wind up the material as fast as it comes from the machine.

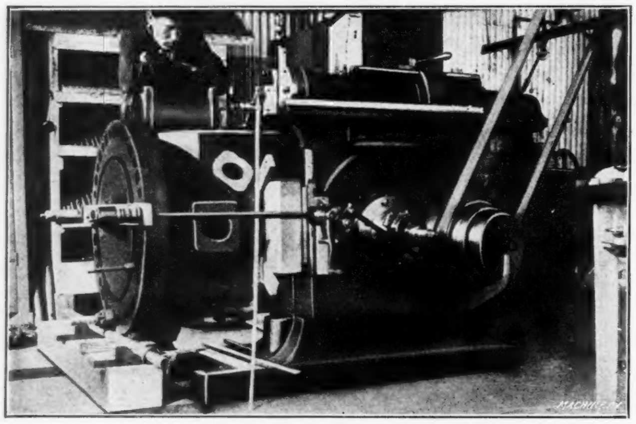
After the wire has been rolled and annealed, it is wound

onto spools of the required size for the market. Some wire is spun over with insulating material and some braided, according to the requirements for which it is to be used. A diagrammatical sketch of an interesting feature of one of the spooling machines, which may be worthy of mention, is shown in Fig. 14. In this *A* represents the reel on which the wire coil is put, while *B* is the spool on which it is wound. This spool is driven at a constant speed. Now, if a kink should occur in the coil of wire at *A*, or, for some other reason, it should be prevented from reeling off easily, the wire would, if it passed directly from the reel to the spool, either be pulled off, or some damage would be done to the machine. In order to prevent this, the wire is passed over an idler pulley at *C*, which is mounted on a lever *D* moving about a fulcrum *E*. When the spooling is proceeding under normal conditions the weight of the lever is great enough to prevent the pull on the wire from lifting the lever, but should an abnormal resistance be placed on the wire, as mentioned, the lever will strike another lever or trip *G*, which will throw out the clutch driving the spool and, hence, stop the machine.

* * *

AN UNUSUAL SHAPER JOB

The accompanying illustration shows a 24-inch shaper, built by the Smith & Mills Co., Cincinnati, Ohio, taking a cut across the exhaust manifold of a 125-horsepower Nuenzel gas engine cylinder head. An idea of the size of this cylinder-head casting may be obtained by comparison with the four-foot rule standing against it. When doing the work on the shaper, the vise and table of the latter were removed and the casting was bolted by a strap and two hook bolts to the apron. Two



A Shaper Job on a Gas Engine Cylinder Head

wooden blocks were used to prevent the bolts from marring the apron, and blocking was also put between the casting and the apron because of the overhanging portion or manifold not being flush with the body of the casting. A roller is fastened to the face of the casting at the bottom. This roller runs on a bar held in V-blocks resting on wedges at the proper height. This arrangement of roller and bar relieves the apron from excessive strain. This unusual shaper job was accomplished in the works of the Olympia Brewing Co., Olympia, Wash.

* * *

WHAT A MAN CAN DO WHEN HE GETS MAD

BY A. P. PRESS

I saw an incident the other day that showed what a man can do when he gets provoked good and proper.

It happened in the toolroom; one of the toolmakers had a fuse tip die to make. The blank was 7/8 inch thick and the fuse tip was about 1 inch long, round at one end and square at the other, with a wing-like projection on each side. The toolmaker was a good man, all right—in fact one of the very best that ever filed a die—but I guess it must have been the "morning after". He had laid out the die all right and had drilled and roughed out most of the stock when it dawned on him that he had made it left-handed, that is, he had laid the templet on the die blank wrong side up. While the die was all right, it, at the same time, was all wrong, or at least the work from it would not fold up so as to bring the burr edge of the metal together.

What did he do? He slapped that piece of work into the scrap-box, took another blank (they were all machined out ready for the templet) and in two hours and twenty minutes he had drilled out his die, roughed out the stock and finished it up ready to harden.

I have seen quick work, but never did I see the same amount of hand work performed in the same length of time as in this case. It pays to get mad once in a while.

* * *

SAFE-BREAKING AT PANAMA

BY F. E. R.

"Yes, a burglar has trials and disappointments", said Blackaller. "To spend four or five exciting hours drilling and blowing open a safe, expecting every minute to hear a watchman's whistle, and then find next to nothing for your pains, is not exactly a salubrious occupation. No, I never was a burglar, but I once helped to blow open a safe under painful conditions, and so have some first-hand knowledge of the 'art'."

"The episode occurred when I was third officer of the *Empress of India* and we were lying at Panama. The machinery used by the French in their attempt at digging the canal was rusting and rotting away under the tropic sun. Our second engineer, Sandy McGuire, invited me to go with him on shore leave and look around a bit. We found many curious evidences of the French occupation. The engines, excavators and other machinery were different from any I had seen and we spent several interesting hours poking around in the jungle that had grown up around them. Suddenly the engineer gave a shout. 'See here, Blackaller; here's a find—a paymaster's safe. It's locked. Some rascal stole it and hid it here, and probably died of the fever before he could get out of the country. See, it's the regular small safe used for carrying money. I'll bet it contains several thousand francs—probably in gold.'"

"Well, I looked at that rusty safe and saw a vision of easy money. The strangeness of the find there in the jungle among those rusty piles of junk almost took my breath away. 'How can we open it?' 'Why we'll go to the ship and get a ratchet, drills, tools and powder, and blow it open—that's what. But we'll have to keep it dark—every blessed nigger around here will want a share in the contents if they see what we've found. You and I will open that safe and share the loot. There's no use in letting a lot of others in', and Sandy's little eyes glittered avariciously."

"Back to the ship we went, and that night we got together the tools and powder. Next morning bright and early we started out to our treasure trove with hearts beating high with anticipation."

"Maybe you think it's an easy job to open a small cast-iron safe, but I don't—that is when you have only a few poor tools and a hell to work in. How we sweated and swore there rigging up a chain around that blasted thing to hold a brace for our ratchet drill! But at last a hole was drilled between the combination lock and the knob, and after much more trouble a half pound of powder was poured into the hole. A fuse was pushed in, and after looking all around to see if the coast was clear, Sandy touched it off and we skurried to cover. A loud explosion rent the air and the door torn from its fastenings sailed away a dozen feet. When the smoke lifted we eagerly peered into the opening. It was absolutely empty—but worse than that the safe had no bottom! If we had only taken the trouble to tip the blamed thing over we could have seen that the bottom had been knocked out long before and that it was as empty as a spendthrift's pocket."

"We stole back to the ship like a pair of sheep-killing dogs, but the story was too good to keep."

* * *

It has been found unprofitable to use old tin cans in the process of detinning for recovering the tin. The cost of collecting, transportation and inability to dispose of the black iron plate are responsible for the cans not being utilized. This information was recently published by the United States Geological Survey which investigated the subject.—*Brass World.*

DIES FOR DROP-FORGING A CRANK-SHAFT

BY J. W. JOHNSON*

The dies for drop-forging the crankshaft shown in Fig. 1 comprise an interesting set of tools, especially to those unaccustomed to crankshaft diemaking. The principal interest of these dies lies in the fact that they were made to forge the collars, pin and adjacent parts of the crankshaft only, the remainder of the ends of the crankshaft being forged under an ordinary trip hammer. The advantages to be gained in forging the crankshaft in short dies are that on account of the

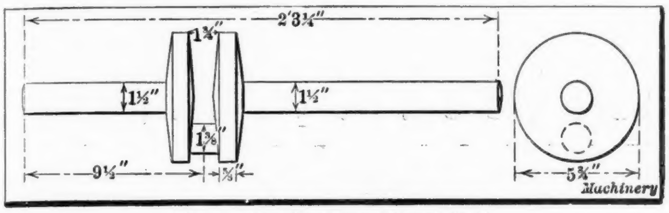


Fig. 1. The Drop-forged Crankshaft

small amount of stock being acted upon, the forging can be thus made under a lighter hammer and stock of smaller dimensions may be used, for it can be worked up by passing it back and forth from the break-down to the impression. Another important advantage in forging this job in short dies is that there is less liability of the forging sticking in the dies while being forged. If long dies were used there would

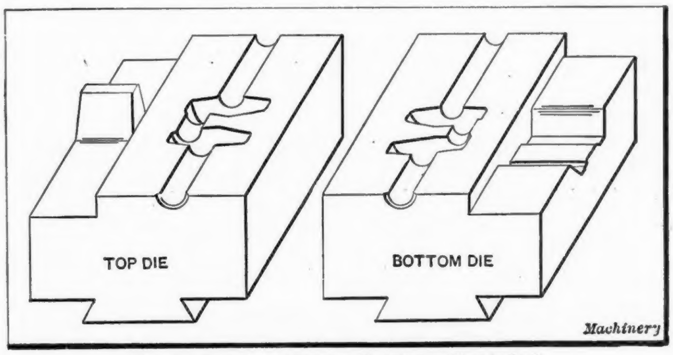


Fig. 2. Forming Dies for Forging a Crankshaft

be more or less trouble from this source. Moreover, when the forgings stick in a long die it is harder to free them than it is from short dies. Short dies are also much easier to keep lined up than long ones; in fact dies long enough to forge this entire crankshaft would give constant trouble by working out of alignment.

Fig. 2 shows the drop-forging dies for forming the forging,

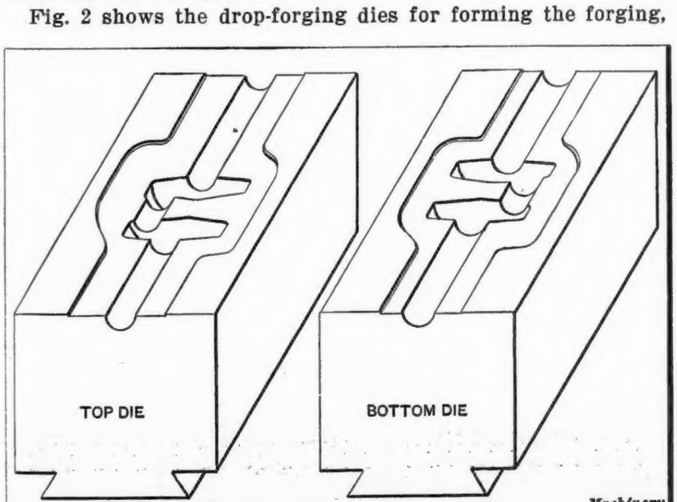


Fig. 3. Finishing Dies

the finishing being done in a separate pair of dies. It will be noticed that the break-down is of unusual width, which is necessary on account of the spreading of the stock. All corners in the forming impressions were well rounded to prevent cold shuts. In making the top die for the forming operation, the projecting piece on the break-down was made by dovetailing a separate piece into the side of the die. If this were not done, a great deal of superfluous labor would have to be done in shaping away the rest of the face of the die. The finishing dies are illustrated in Fig. 3, and, of course, the impressions are like those in the forming dies, except that the corners are not rounded as much and are flashed. It is obvious that no break-down or anvil was required on the finishing dies.

The trimming die and punch for this forging are shown in Fig. 4, and it will be noticed that the die is made in halves and left open at the front for hot trimming. The punch was milled out to receive the forging for trimming so that it would not bend during the trimming operation.

The stock used for forging this crankshaft was nine inches long and four inches square. The first operation consisted of forging a tong-hold on one end. The piece was then put back in the fire, heated all over to a good forging heat, and

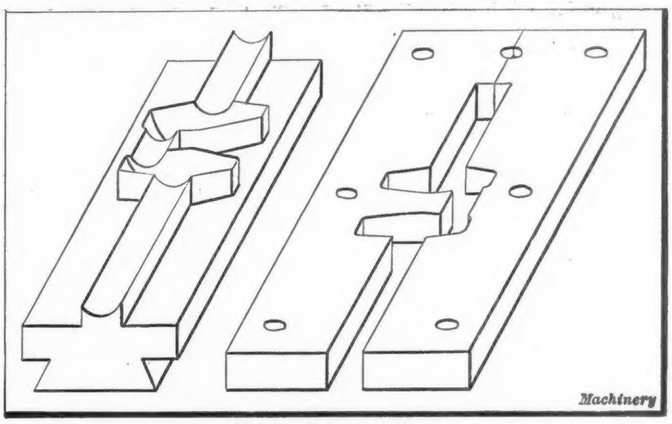


Fig. 4. Trimming Dies

the first blow of the hammer given the piece when in the break-down. Care was necessary in locating the piece in the die for the first blow, for this crankshaft is longer on one side of the collars than on the other. The stock worked up very rapidly, as it drew from the smaller sections and flowed into the collars. Quite a number of blows were necessary to draw enough stock from the ends to get the collars full.

After distributing the stock by means of the forming dies, a few blows in the finishing die brought the corners up and sized the forging, after which it was hot-trimmed in the ordinary manner in the trimming dies shown in Fig. 4.

* * *

The statistics compiled by the *Archiv für Eisenbahnwesen* give the total mileage of the world's railways in 1910 as 640,158 miles; the total increase in the last year was 14,460 miles and in the last decade, 149,092 miles. This increase in mileage had been exceeded by but one previous decade, that between 1880 and 1890, when 152,179 miles of railway were built. Of all the railways in Europe more than 50 per cent are owned by the respective governments: 60 per cent of the railways in Africa, nearly 60 per cent of those in Asia and about 95 per cent of those in Australia are owned and operated by the State. It is interesting to note that while Great Britain has no state railways, and Canada only 1718 miles out of a total of 24,731 miles, this form of administration prevails almost exclusively in the British possessions of Asia, Africa and Australia.

It is also of interest to record the growth of the world's railway system from the time of its beginning. In 1840 there were about 4800 miles of railway in the world; in 1850, 24,000; in 1860, 67,000; in 1870, 130,000; in 1880, 231,000; in 1890, 383,000; in 1900, 490,000; and in 1910, as mentioned, 640,000 miles.

* * *

At a recent meeting of the Society of German Engineers, Herr Hammer, after having reviewed the improvements in the locomotives shown at the recent Turin exposition in Italy, stated that the following lines of development are being followed: A high steam pressure; the use of steam more highly superheated; valve gear improvements; utilization of the heat of the waste gases now escaping through the smoke-stacks; and the purification and pre-heating of the feed water.

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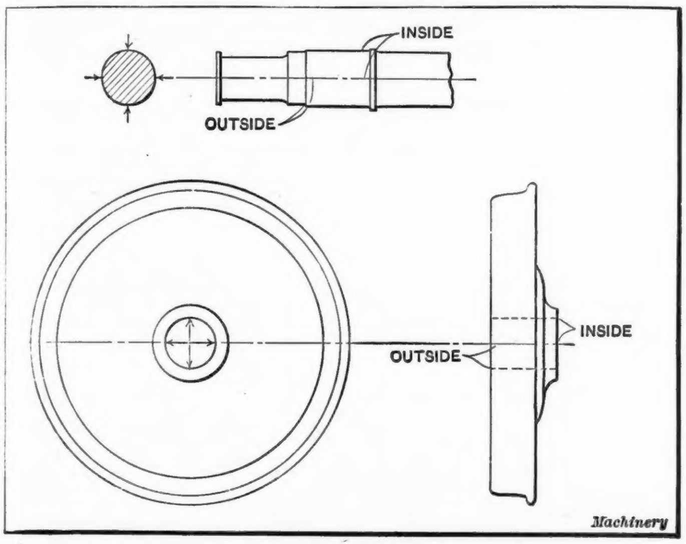
TABLE OF WHEEL AND AXLE PRESS FITS

Axle									Wheel												
	Diameter, Wheel Fit										Diameter of Bore										
Size of Journal, Inches	Outside End, Inches	Inside End, Inches	Condition of Finish	Cutting Speed, Feet per Min.	Depth of Cut, Inches	Feed, Inches	Make of Lathe	Condition of Lathe	Diameter, Inches	Material	Outside End, Inches	Inside End, Inches	Condition of Bore	Cutting Speed, Feet per Min.	Feed, Inches	Cuts per Wheel	Pressure for Fit, Tons	Service of Wheel	Make of Mill	Condition of Mill	General Remarks
5 x 9	6.345 6.343	6.349 6.349	G	40	$\frac{1}{32}$	$\frac{1}{8}$	Bridgeford	G	33	C. I.	6.339 6.337	6.336 6.337	G	25	$\frac{3}{16}$	2	50	T T	Putnam	G	Gage used, Niles Lubricant, Paint
4½ x 8	5.708 5.704	5.706 5.701	G	40	$\frac{1}{32}$	$\frac{1}{8}$	Bridgeford	G	33	C. I.	5.700 5.702	5.700 5.702	G	25	$\frac{3}{16}$	2	50	T T	Putnam	G	
3¾ x 7	5.341 5.341	5.345 5.345	G	40	$\frac{1}{32}$	$\frac{1}{8}$	Bridgeford	G	33	C. I.	5.332 5.332	5.336 5 331	G	25	$\frac{5}{16}$	2	65	T T	Putnam	G	
3¾ x 7	5.339 5.339	5.338 5.338	G	40	$\frac{1}{32}$	$\frac{1}{8}$	Bridgeford	G	33	C. I.	5.333 5 333	5.333 5.333	G	25	$\frac{5}{16}$	2	40	T T	Putnam	G	
5½ x 10	5.480 5.480	5.480 5.480	G	25	$\frac{1}{32}$	$\frac{1}{8}$	Bement-Miles	G	30	S. T.	5.469 5 467	5.465 5.470	G	25	$\frac{3}{16}$	2	75*	E T	Putnam	G	
5½ x 10	6.802 6.802	6.803 6.803	G	40	$\frac{1}{32}$	$\frac{1}{8}$	Bridgeford	G	33	S.	6.802 6.802	6.802 6.802	V G	25	$\frac{3}{16}$	2	32*	T T	Putnam	G	
4½ x 8	5.766 5.762	5.764 5.760	V F	50	$\frac{1}{32}$	$\frac{1}{16}$	Bridgeford	G	33	C. I.	5.744 5.744	5.743 5.743	G	18	$\frac{1}{8}$	2	75*	Fr	Niles-Bement	G	Gage used, Crosby Lubricant, Paint
4½ x 8	5 763 5.763	5.761 5.763	P	50	$\frac{1}{32}$	$\frac{1}{16}$	Bridgeford	G	33	C. I.	5.7445 5.7445	5.743 5.743	G	18	$\frac{1}{8}$	2	61	Fr	Niles-Bement	G	
4½ x 8	5.769 5.775	5.770 5.769	V F	50	$\frac{1}{32}$	$\frac{1}{16}$	Bridgeford	G	33	C. I.	5.756 5.756	5.7545 5.7545	F	18	$\frac{1}{8}$	2	62	Fr	Niles Bement	G	
5½ x 10	6.873 6.8715	6.872 6.869	P	50	$\frac{1}{32}$	$\frac{1}{16}$	Bridgeford	G	33	C. I.	6.851 6.851	6.851 6.851	G	18	$\frac{1}{8}$	2	75	Fr	Niles-Bement	G	
5½ x 10	6.969 6.969	6.972 6.971	V G	50	$\frac{1}{32}$	$\frac{1}{16}$	Bridgeford	G	33	C. I.	6.956 6 956	6.9545 6.9545	G	18	$\frac{1}{8}$	2	75	Fr	Niles-Bement	G	
5½ x 10	6.912 6 912	6.912 6.912	G	50	$\frac{1}{32}$	$\frac{1}{16}$	Bridgeford	G	33	C. I.	6.898 6.896	6.900 6.898	V F	18	$\frac{1}{8}$	2	62	Fr	Niles-Bement	G	
4½ x 8	5.746 5.749	5.752 5.751	P	25	$\frac{1}{32}$	$\frac{3}{32}$	Niles	F	36	C. I.	5.740 5.740	5.738 5.738	V G	16	$\frac{9}{16}$	2	80	Pa	Putnam	G	Gage used, Niles Lubricant, Paint
4½ x 8	5.748 5.743	5.749 5.749	V F	25	$\frac{1}{32}$	$\frac{3}{32}$	Niles	F	36	C. I.	5.740 5.740	5.740 5.740	G	16	$\frac{9}{16}$	2	57	Pa	Putnam	G	
5 x 9	6.371 6.371	6.380 6.382	G	25	$\frac{1}{32}$	$\frac{3}{32}$	Niles	F	33	C. I.	6.362 6.362	6.362 6.362	G	18	$\frac{9}{16}$	2	65	T T	Niles	G	
3¾ x 7	5.355 5.355	5.356 5.359	V F	25	$\frac{1}{32}$	$\frac{3}{32}$	Niles	F	33	C. I.	5.352 5.352	5.348 5 348	V F	18	$\frac{3}{32}$	1	60	T T	Niles	G	
3¾ x 7	5.388 5.390	5.395 5.398	G	25	$\frac{1}{32}$	$\frac{3}{32}$	Niles	F	33	C. I.	5.383 5.383	5.383 5 383	G	18	$\frac{9}{16}$	2	60	T T	Niles	G	
3¾ x 7	5.260 5.257	5.257 5.256	G	25	$\frac{1}{32}$	$\frac{3}{32}$	Niles	F	33	C. I.	5.252 5.252	5.250 5.250	V F	18	$\frac{9}{16}$	2	32	T T	Niles	G	
4½ x 8	5.763 5.762	5.763 5.762	G	30	$\frac{1}{32}$	$\frac{1}{8}$	Bement & Son	V G	33	C. I.	5.753 5.753	5.752 5.752	G	24	$\frac{1}{8}$	2	52†	Fr	Bement-Miles	G	Gage used, Bristol Lubricant, White Lead and Oil
4½ x 8	5.787 5.783	5.797 5.792	G	35	$\frac{1}{32}$	$\frac{5}{32}$	Bement-Miles	G	36	S.	5.785 5.785	5.785 5.785	G	18	$\frac{1}{16}$	2	119*	Pa	Niles	V G	
4½ x 8	5.774 5.774	5.777 5.776	V F	35	$\frac{1}{32}$	$\frac{5}{32}$	Bement Miles	G	36	S.	5.767 5.771	5.775 5.776	V F	18	$\frac{1}{16}$	2	51	Pa	Niles	V G	
5 x 9	6.436 6.438	6.432 6.433	P	35	$\frac{1}{32}$	$\frac{5}{32}$	Bement-Miles	G	33	C. I.	6.401 6.404	6.412 6.410	V G	24	$\frac{1}{8}$	2	85	Fr	Bement-Miles	G	
3¾ x 7	5.336 5.345	5.341 5.345	V F	35	$\frac{1}{32}$	$\frac{5}{32}$	Bement-Miles	G	33	C. I.	5 333 5.333	5.337 5.337	V F	24	$\frac{1}{8}$	2	64	Fr	Bement-Miles	G	
4½ x 8	5.768 5.765	5.776 5.773	V F	25	$\frac{1}{32}$	$\frac{5}{32}$	Bement-Miles	V G	36	C I.	5.7125 5.7125	5.7115 5.7115	G	18	$\frac{1}{8}$	2	Wheels not pressed on	Pa	Niles	V G	....
4½ x 8	5.7765 5.778	5.780 5.780	G	35	$\frac{1}{32}$	$\frac{5}{32}$	Bement-Miles	G	36	C. I.	5.728 5.729	5.728 5.729	G	18	$\frac{1}{8}$	2		Pa	Niles	V G	
4½ x 8	5.781 5.781	5.7865 5.788	V G	35	$\frac{1}{32}$	$\frac{5}{32}$	Bement-Miles	G	33	C. I.	5.729 5.729	5.729 5.729	G	18	$\frac{1}{8}$	2		Pa	Niles	V G	

V G = very good; G = good; V F = very fair; F = fair; P = poor.—C. I. = cast iron; S. T. = steel-tired; S = steel.—T T = tender truck; E. T. = engine truck; Fr = freight car; Pa = passenger car.
* Taken off. † Taken off before pressed full distance.

WHEEL AND AXLE PRESS FITS

The accompanying table gives data for wheel and axle press fits, as used in different railroad shops. The data given in the tables requires no further explanation, as it merely records the practice followed in various shops. The writer had the opportunity of obtaining this data during the carrying out of a systematic investigation covering the points recorded. He believes that a great deal of interest is attached to this



Illustrations showing where Dimensions given in the Accompanying Table are measured

subject, as he found that in all the railroad shops visited the men were very much interested in the methods followed in other shops. It will be seen that the practice differs considerably in the various places, both as regards the speeds and feeds used in wheel and axle turning and as regards the allowances for fits. Five shops are represented in the table, the data from each being grouped together as indicated. Two dimensions are given for each axle or bore diameter, these being measured in two directions at right angles to each other as indicated in the accompanying illustration. H.

* * *

CHECKING LIST FOR DRAWINGS

BY E. E. MINARD*

The questions are sometimes asked, "Why is it necessary to check drawings? Why cannot the draftsman be depended upon to make them right in the first place?" As a matter of fact, however, draftsmen are no more infallible than other men, although probably no less so. There are few who can make a drawing with the average amount of detail without some error or omission being found by a competent checker. The errors in design or dimensions are apt to be quite costly if not discovered before the parts are machined or assembled. It has been the experience of the writer that the most costly errors occur where they are least expected, and particularly with regard to matters which it has not been considered necessary to check. If the drawings cover simple and inexpensive parts, the checking might cost more than an occasional spoiled piece, and, in that case, it might be dispensed with, but when the drawings cover expensive parts, like tool work, careful checking is imperative.

It is often claimed that draftsmen are apt to be careless when they know that their work is to be checked afterwards. This may be true if the discipline is lax and the checker is inefficient, but if a standard checking list, such as given in this article, is handed to the draftsman with the understanding that his work must conform to its requirements, a marked increase in the efficiency of the draftsmen will, in most cases, be noted. The checking list submitted herewith is given as an example for one special class of work. Different lists should be prepared for different classes of work. In making up such a list, one should guard against the mistake of trying to make this standard checking list as complete as an instruction book. To make it efficient and useful, it must be brief in every item, and must be used simply as a supplement to other necessary instructions. The sole object should be to instantly call to the mind of the draftsman the requirements of the standard practice. The list given below is for punch and die work drawings, and will, of course, vary according to the practice and working conditions of different drafting-rooms.

* Address: 722 Saginaw St., W., Lansing, Mich.

Standard Checking List—Punches and Dies

Design Approval:

1. Authorization, requisition, memorandum, blueprint, sketch or sample.
2. Yearly requirements.
3. Grade of tool.
4. Method of operation.
5. General and specific requirements of departments.
6. Harmony in design, compared with other up-to-date tools.
7. General design.

Assembly:

1. Views and projections.
2. Work to be easily placed in die.
3. Work to be easily removed from die.
4. Same gaging points on succeeding operations.
5. Parts to be readily machined and assembled.
6. Interference of moving parts, slides, etc.
7. Burr side of blank in proper relation.
8. Provision for grinding.
9. Stripping and knockout devices to be adequate.
10. Clearance for slugs and burrs.
11. Setting pins.
12. Safety pins for unsymmetrical blanks.
13. Punch height to clear work during forming operation.
14. Size of punch shank to be standard.
15. Relation of shut height to available presses.
16. Size of dowel pins and standard screws.

Details:

1. Views and projections.
2. Views of details placed in same relative positions as assembly.
3. Detail to check with assembly.
4. Easily machined.
5. Easily assembled.
6. Easily hardened without liability to check.
7. How fastened in place.
8. Scaling and calculating of dimensions.
9. Intermediate dimensions.
10. Overall dimensions.
11. Limits.
12. Size and location of holes.
13. Finish marks.
14. Grinding marks.
15. Detail number.
16. Name.
17. Number of pieces required.
18. Material.
19. Hardened.
20. Ground.
21. Forging.

Title:

1. Class and type of punch and die.
2. Part number.
3. Model number.
4. Scale.
5. Initials.
6. Drawing number.
7. Date drawn.
8. Date traced.

General Requirements:

1. Neatness and clearness.
2. Crowding of views, details and notes.
3. Lettering.
4. Lines.
5. Section-lining.

The different men in the drafting-room use all or part of this list, as required. The designer uses the section on "Assembly." The head of the division or department uses the sections under the headings "Design Approval," and "Assembly." The detailer uses the portion under the headings "Details," "Title," and "General Requirements." The tracer need pay attention only to the section of "General Requirements," after which the checker uses the complete list with the exception of "Design Approval." It is understood that before a list of this kind can be used successfully, detailed instructions in separate form must be given to the draftsmen, covering all the parts to which attention is called in this list.

* * *

Men who are absolutely convinced of the accuracy of their opinions will never take the pains of examining the foundation on which they are based.—*Buckle.*

RELATIVE FIELDS OF THE BOARD AND STEAM DROP HAMMERS

BY H. TERHUNE*

It has been suggested that the steam drop hammer is rapidly replacing the board drop hammer. The writer wishes to state that after visiting practically all of the drop-forge plants and manufacturing plants making drop forgings, he is not of the opinion that the steam drop is replacing the board drop on the same class of work, but that the nature of the work at the present time has outgrown the limits of the board drop, which, even from a mechanical point of view, has always been placed at 3000 pounds falling weight.

In the Middle West and along the Lakes, where the bulk of heavy forging is done, drop hammers of from 2000 to 16,000 pounds falling weight are required. Here we find, perhaps, one and one-half board drop to every steam drop hammer, with a total falling weight much in favor of the steam drop; but from the western borders of Pennsylvania and New York to the Atlantic coast the conditions change almost as abruptly as does standard time, and we find about twelve and one-half board drop hammers to every one steam drop. The bulk of the board drops are from 800 to 1500 pounds and the steam drops from 2000 to 5000 pounds. Generally speaking, it is as difficult to convince people in New England of the merits of the steam drops as it is to do the same thing with relation to the board drops in the Detroit and Cleveland districts.

Each hammer has its advantages. The managers of the drop-forge shops say that a certain class of accurate work can be done more economically on a board drop than on a steam drop, provided that it does not require a hammer larger than from 1500 to 2000 pounds, and a number of plants that have been provided with all steam drop hammers have recently put in board drops to take care of this class of work. However, there are four or five drop-forge shops in the Middle West where nothing is considered except steam drop hammers for all classes of work.

Nearly everyone admits that the cost of operation and repairs is greater on the steam drop hammers, but at the same time about one-third more work can be done on these. The writer has failed, however, to obtain exact data as to the relative cost of operation and upkeep of the two types of machines. Some claim that these items are about double for the steam drop hammers, but this seems rather high.

The power required for board drop hammers varies considerably with the nature of the work. Very little power is required at the point of "pick-up" if the work is practically "die to die." A great deal more power is required when the work is very soft and there is no rebound; this is largely due to the small amount of kinetic energy in the driving pulleys, the rolls thus having to pick up a dead load from rest. When there is a good rebound, with the knock-off properly timed, the board will have practically the same upward velocity as have the rolls when they come together, and the ram is simply continued on its upward stroke by the rolls. Heavy flywheels would be an advantage, but makers of drop hammers would hardly consider them on account of the danger of the heavy overhanging weight on the end of the driving shaft. In several shops, however, they have been used for years without an accident, and in these places the manufacturers will consider no other construction.

It is rather difficult to find a better machine than the board drop hammer on certain classes of work, at least in cases, for example, where hammers of from 500 to 1500 pounds (or even up to 2000 pounds) are used, and the shop is driven by water power or natural gas at 12 cents per 1000 cubic feet, or even electric current at from one to one and one-half cents per kilowatt-hour, especially when coal is as high as in New England.

When the work is heavy and requires a great deal of breaking down, and there is considerable drawing and bosses to be forged, and even when light work is to be done having thin sections that cool quickly, such as gear blanks with thin webs, I-sections, etc., requiring quick sharp blows, the steam drop will make the best showing in nearly all cases.

At the present time the waste heat boiler mounted on the top of each heating furnace is receiving considerable attention. This boiler generates the steam for the hammer with little or no extra fuel other than that required for heating the work being forged. If the waste heat of each furnace were sufficient and could be utilized to generate enough steam for its own drop hammer, regardless of size, the board drop hammer would become obsolete on account of the superior economy of the steam hammer. At present, the relative advantages of each, however, depend, as we have seen, on many conditions, some of which are purely local in their character.

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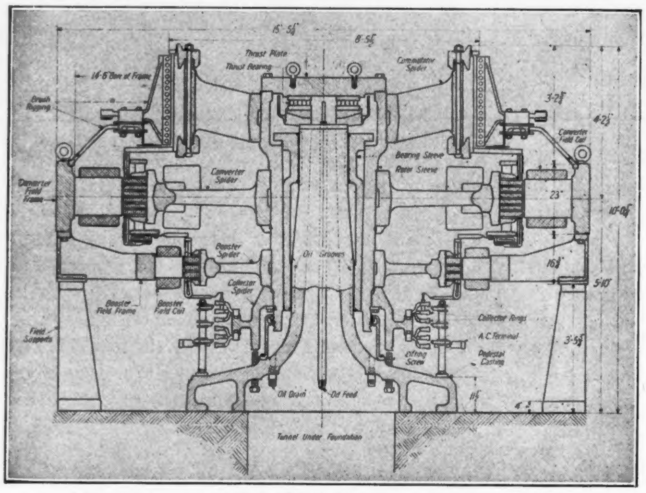
* * *

LARGE VERTICAL ROTARY CONVERTERS

Two 3000 K. W. vertical rotary converters have recently been built by the Westinghouse Electric & Mfg. Co. in its East Pittsburg works. These machines are of especial interest because they are the largest rotary vertical converters ever constructed. They were built for the New York Edison Co. The accompanying illustration shows a sectional drawing of these converters, some of the mechanical features of which are rather interesting and different from those hitherto used on ordinary electrical machines. The pedestal on which the armature rotates is made in one piece from a hollow steel casting. A much more rigid construction is possible in this way than with a steel pedestal provided with a flange on its lower end bolted to a cast-iron base. A roller thrust bearing is arranged at the top of the pedestal to take the weight of the revolving element. This bearing rests on the plate having a spherical seat carried on the pedestal, so that perfect alignment is possible. The roller bearing can be easily taken out by removing the top plate of the machine. When it is necessary to remove the top plate, the weight of the rotating parts is carried by six 1¾-inch bolts which pass through the flange at the base of the pedestal. When the top plate is taken off these bolts are screwed up until they raise the rotating element a trifle and assume its weight.



Section through Large Westinghouse Rotary Converters

* * *

ARTIFICIAL RUBBER

A consular report states that a factory for producing artificial rubber has been established at Ymuiden, in Holland. It is stated that the company that has started this factory has succeeded in producing a substance having the qualities of rubber, and in addition, some advantages over genuine rubber. The principal ingredients of the product are said to be fresh sea fish with about 15 per cent of natural rubber, the resulting substance being as flexible and as elastic as rubber, but costing but one-sixth of real rubber. The low price of the product is caused partly by the use of the by-products, which can be employed as artificial fertilizers. It is stated that this artificial rubber can be vulcanized, that it is benzine-proof and that it can resist the effect of heat. The substance much resembles real rubber, but the slightly fishy smell betrays the chief ingredient. It is explained that this will be prevented by extracting the fat from the fish used. The development certainly is interesting, providing the claims, too, are not "fishy."

WATCH MOVEMENT MANUFACTURE—4

METHODS, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO., SOUTH BEND, IND.

BY DOUGLAS T. HAMILTON*

The final operations on a watch movement, such as jeweling, stem fitting, banking, dialing, balance truing, over-coiling, spring truing, finishing, timing and adjusting, are necessarily hand operations which require the attention of experienced workmen. The assembling operations are, of course, also accomplished by hand. Before the winding wheels, plates, bridges or other exposed portions of the movement are ready

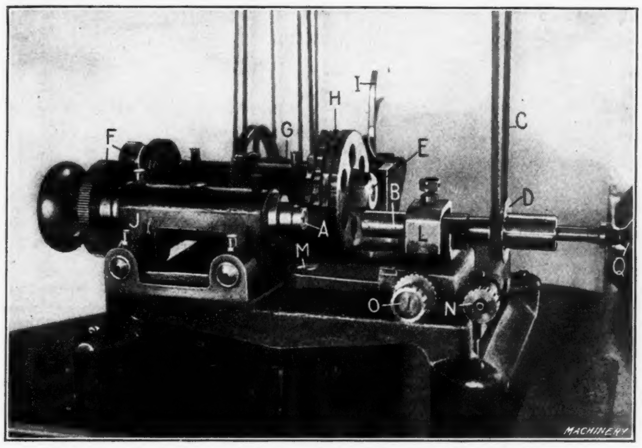


Fig. 40. Machine used in Damaskeening Winding Wheels, etc.

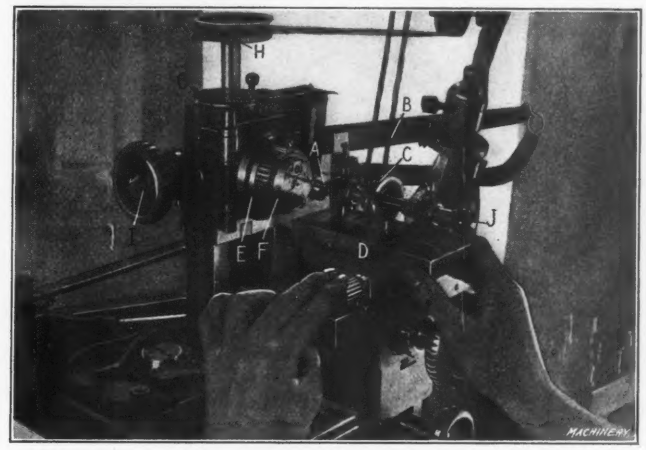


Fig. 41. Damaskeening Machine of the Upright Type for Decorating Bridges, Plates, etc.

to be assembled, they are usually decorated by means of a tortoise shell lap charged with carborundum, held in a damaskeening machine. In addition to the operations mentioned, the methods used in making the dials will be dealt with in the following.

Decorating Watch Movement Parts

To produce the decorations on the winding wheels, etc., the parts are held in the spring chuck *A* of the damaskeening

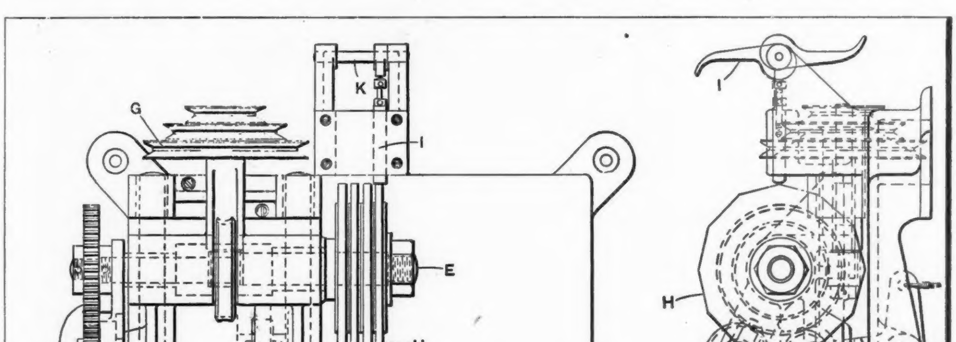


Fig. 42. Construction of the Damaskeening Machine shown in Fig. 40

machine shown in Fig. 40. The tortoise shell lap, which for the steel parts is charged with diamond dust, is held in the spindle *B*, the latter being rotated by a belt *C* running on pulley *D*. The work is rotated by the cam-shaft *E* through change gearing *F*, the former receiving power from grooved pulleys *G*, through a worm and worm-wheel.

The oscillating movements of the work required to produce the desired decorations are obtained from irregular faced cams *H*, which, through an adjustable pawl *I* transmit the required oscillating movement to the head *J*. As is shown in Fig. 42, this pawl can be slid back and forth on pin *K*, and thus be brought in contact with the irregular faces of the various cams. The entire head which carries the change gears and work is thus moved back and forth while the work is being rotated.

The head *L* carrying the spindle in which the diamond-charged lap is held is pivoted at a point *M*, and is made to move through an arc by operating knob *N*, which has a worm formed on its forward end meshing in a rack cut in the base of the holder. This adjustment of the spindle is necessary to change the angular position of the face of the lap in reference to the work, so that fine or wide "wavy" decorations can be produced. The head carrying the lap can also be adjusted laterally to conform to the diameter of the required circle by means of a knob *O* and screw *P*. The lap is kept in contact with the work by the operator pressing on knob *Q*.

Damaskeening Bridges and Plates

The bridges and plates are decorated in a machine which differs in construction to a considerable extent from that shown in Figs. 40 and 42. This machine is shown in Fig. 41 at work on the rear watch plate. As before, the decorating is accomplished with a tortoise shell lap, which in this case, however, is charged with carborundum. The lap is held in a spindle *A*, which is rotated at a high rate of speed by means of a belt *B* and pulley *C*. The table *D* on which the lap spindle is held can be tilted to an angular position, so as to change the width of the decoration. For large work, the table can be moved back and forth, and is provided with an index, so that all lines can be spaced the same distance apart.

Head *E*, carrying chuck *F*, which holds the work, can be given a variable oscillating movement by means of a worm and worm-wheel, the former being driven by a pulley *G* from the overhead works. The belt driving the worm is shifted by means of a foot lever, stops being provided to give the required arc of oscillation.

When irregular patterns are desired, irregularly-faced cam-

* Associate Editor of MACHINERY.

strips retained on the rear of the machine are brought into play. These cams, through the medium of a follower, impart a forward and backward movement to the head, the latter being raised and lowered automatically by means of pulley *H*. This pulley is driven by a round belt from the overhead works, and by means of stops which shift the driving belt, its direction of rotation is changed to raise and lower the head. The head can also be moved back and forth by means of knob *I*.

The variety of patterns which can be produced on this simple machine is very great. By using any one of the irregularly-faced cams, the outline of the pattern is altered, and by using the same cam, but changing the angle of inclination of the lap spindle, an entirely different pattern is produced. Various combinations of patterns can in this way be produced without special attachments. The lap, of course, is kept in

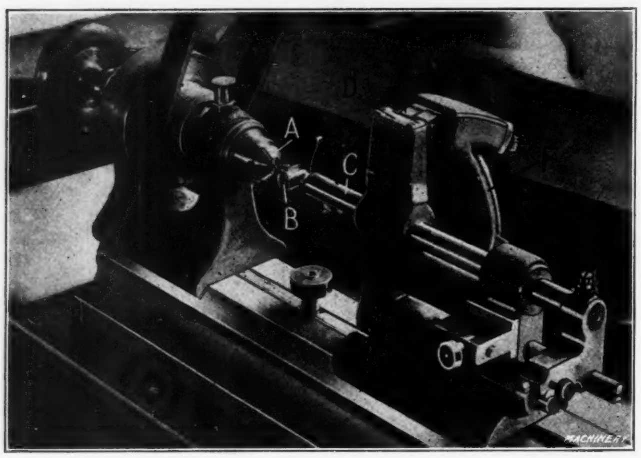


Fig. 43. Jewel "Letting-in" Machine and Caliper Rest for governing Diameter of Hole for Jewel

contact with the work by the operator, who presses on the knob *J* with the palm of her hand.

Fitting Jewel Settings and Jewels

The jewels, which act as bearings for the staffs, are not in all cases set directly in the plates and bridges, but are located in settings, the latter being retained in the plates and bridges. The machine used for producing the holes in the settings for the jewels is shown in Fig. 43. The setting is held in a spring collet *A*, and the boring tool in a holder *B*, provided with a shank fitting in spindle *C*.

A device called a "caliper rest" is used in connection with this machine for determining the diameter of the hole for the

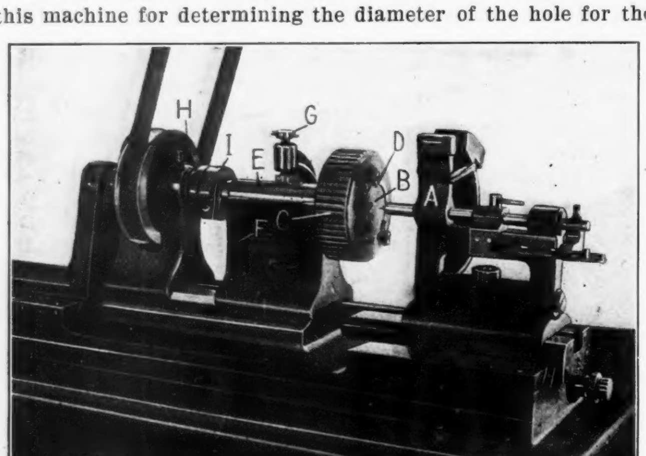


Fig. 44. "Cutting-in" Machine for Jewel Settings

jewel. This caliper rest is shown in detail in Fig. 45. The jewel is placed between the two jaws *D* and *E*, and as arm *F* is cast rigid with the base, it follows that (when the jaws are together) arm *H*, which is pivoted at a point *G*, must be deflected when the jewel is placed between the jaws. As radius *R* is twice *r*, the spindle *C* of the machine which fits in the bushings *I* is moved out a distance equal to the radius of the jewel. Then, as the cutter is set directly on the center line or axis of the machine spindle, it will produce a hole (when cutting on one side only) equal to the diameter of the jewel.

The plate or bridge in which the setting is retained is bored out in the "cutting-in" machine shown in Fig. 44. This machine is also provided with a caliper rest *A* similar in construction to that shown in Fig. 45. The work is held in the quill chuck *B*, which is tightened onto the work by turning the corrugated ring *C*. This ring, in turn, operates a ring having cam grooves which draw in the dogs *D* to grip the

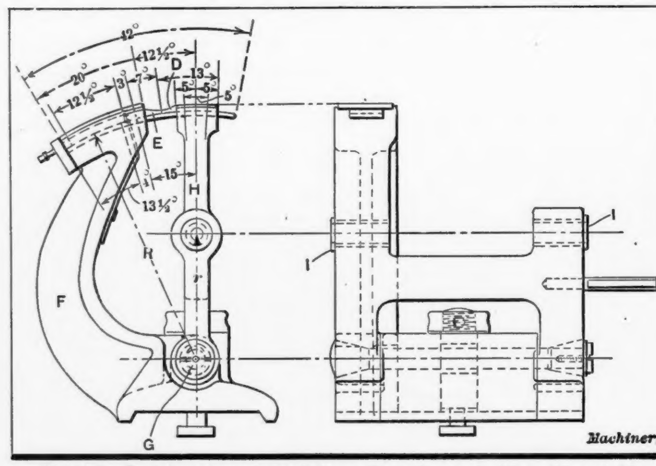


Fig. 45. Construction of the Caliper Rest shown in Figs. 43 and 44

work. This chuck is provided with a quill in which the spindle of the chuck rotates. The quill *E* is held by a clamp screw *G* in a U-shaped groove cut in the rest *F*. The spindle of the chuck is driven from pulley *H* by means of a clutch *I*. This method of holding and driving the chuck is conducive to greater accuracy, because vibration and wear are practically

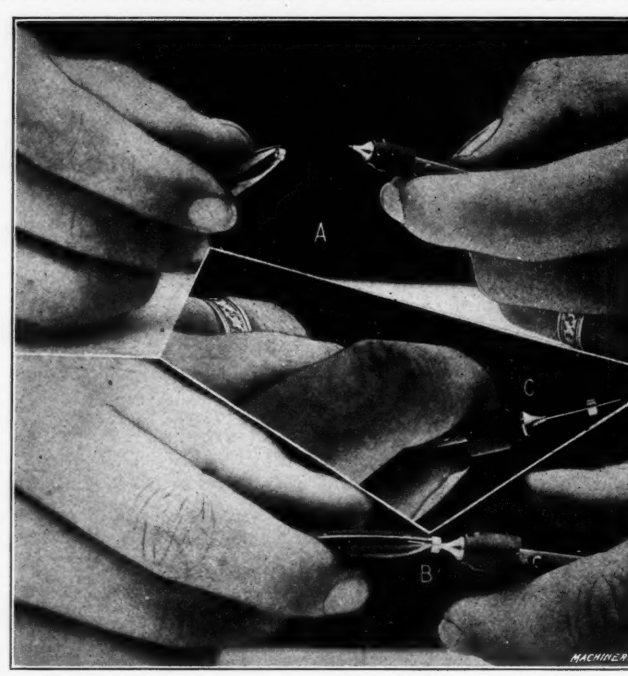


Fig. 46. Gaging the Holes in Jewels by Means of a Needle Gage

eliminated. The pull of the belt does not affect the alignment of the spindle, and the latter is free to rotate in the quill which is clamped rigidly in the rest.

Another good feature of the quill chuck is that it can be removed from the machine and replaced with the assurance that it will always run true and be in perfect alignment. A chuck is also made for every different part, and is used only for that part, thus insuring interchangeability—one of the chief objects sought in modern manufacturing.

Polishing and Gaging Jewels

The jewels used for bearings in watches are obtained from Switzerland already drilled. It is necessary, however, to lap the holes and round the corners (making what is called an "olive" hole), so the staff will rotate in it with as little friction as possible. The jewel is held in a small speed lathe, the spindle of which is rotated at about 150,000 R. P. M. The polishing is accomplished by a lap made from peg wood—the same class of wood as is used for pegging shoes—charged with No. 6 diamond powder.

After lapping, the holes are gaged by means of a "needle" gage in the manner illustrated in Fig. 46. At *A* the gage is shown in position for inserting it into the jewel; at *B* the operator has forced the needle into the jewel, and is obtaining the correct reading on the scale; and at *C* the needle is forced out to the limit. The needle is slightly tapered and is set in a holder, and its position with reference to the scale gives the diameter of the hole in the jewel. It is absolutely necessary that the jewel be placed on the needle in the manner illustrated at *A* in Fig. 46, because of the slenderness of the needle. If it were attempted to put the jewel on the needle when the latter was in the position shown at *B* or *C*, a broken needle would be the result.

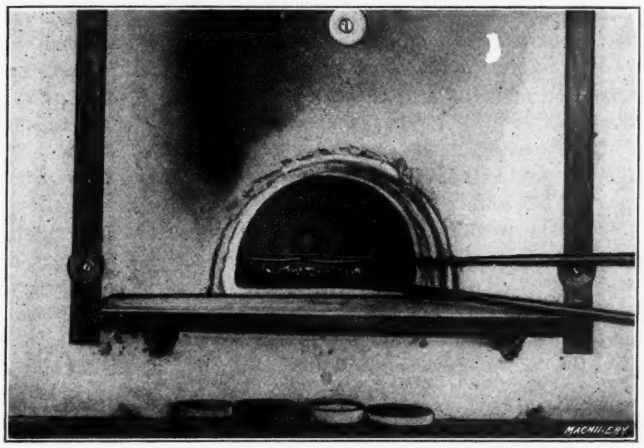


Fig. 47. Furnace for "Baking" the Enamel on the Watch Dials

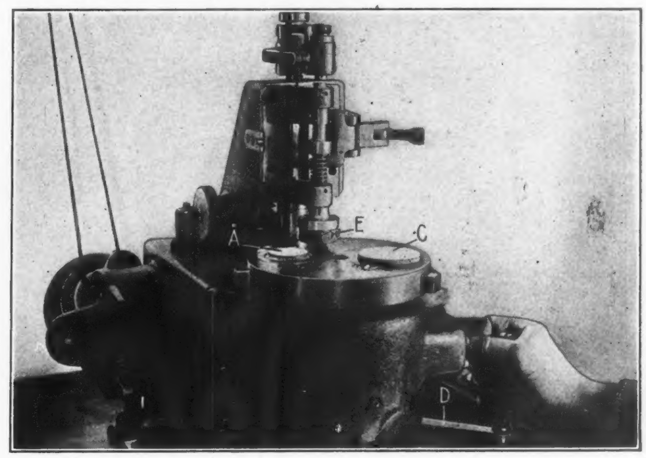


Fig. 48. Dial Printing Machine

Making Watch Dials

A watch dial consists of a copper disk or base upon which three or more layers of enamel are deposited. The first coat —known as the grip coat—is much harder than the top or last coat. The enamel used for watch dials comes from Germany. It is received in the form of lumps, which are broken up and put in a grinding barrel provided with a wedgewood lining. The grinding is accomplished by porcelain balls, which are put in the barrel with the lumps of enamel. After the enamel is ground it is sifted through bolting cloth—the same as that used in flour mills—two meshes of this cloth being used. The finely powdered enamel is used on the back of the dial—it being absolutely necessary that the enamel used on the front of the dial be of a uniform size of grain.

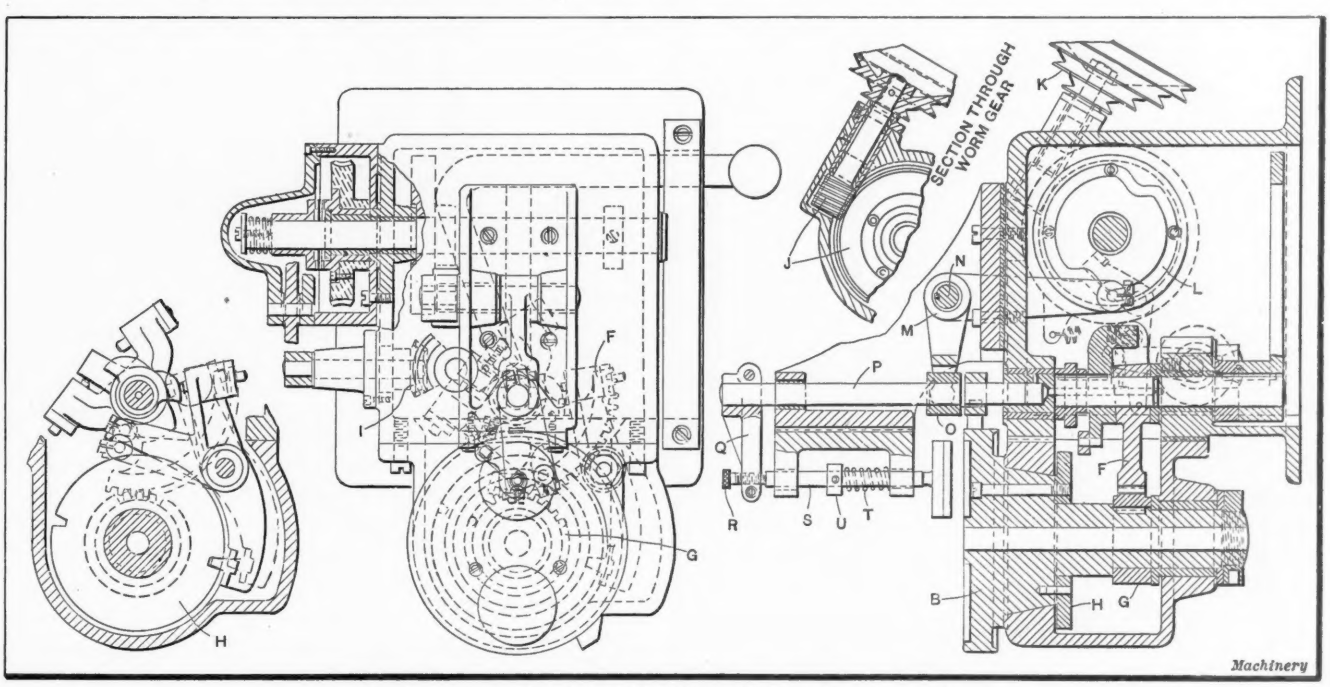


Fig. 49. Construction of the Dial Printing Machine shown in Fig. 48

After the copper bases have been blanked out in the punch press, the dial feet are riveted in. Small rings are then soldered around the base of these dial feet so that they will be held securely. In soldering the dial feet into the copper blank, the latter is bent out of shape, so it is necessary to flatten it on an ordinary flat die.

When the dials or bases have been prepared in the manner described, the copper bases are laid flat in a sieve tray, after they have been cleaned in acid, washed and dried. The tray containing the copper blanks is then taken to a sifting device which holds the ground enamel, the latter being sifted over the dials by means of a knocker, producing a slight vibratory movement of the container, thus spraying the enamel evenly over the copper blanks. After an even deposit of enamel has been sprayed on the copper disks, they are dried over a gas fire. Both the back and front of the copper disks are treated in this way. Then the front of the dial receives a second coat of a uniform thickness. After applying this coat, the enamel is fused in the gas furnace shown in Fig. 47, where the dials remain for about one minute. They are then taken out and allowed to cool off gradually.

The dials used on expensive watches are as a rule double sunk, that is, they are composed of various sized disks soldered together, that portion of the dial around the second hand usually being depressed. In such a case the enamel-coated disk is taken to a small grinding machine where that portion of the dial to be sunk is removed by means of a copper arbor coated with flour of emery, and located by means of a pilot fitting a punched hole in the dial. This emery charged arbor grinds away the enamel down to the copper on each side of the dial. The dials are now coated with paraffine wax, and an aluminum cup is placed around the ground ring in the enamel; then this is luted in place with wax. This aluminum cup is now filled with pure nitric acid, which eats or burns through the copper in about ten minutes.

While eating out the small copper disks with nitric acid, the dials are placed in a box-shaped container, provided with a rather ingenious arrangement to carry away the fumes of the acid. As is well known, nitric acid fumes, if in the vicinity of steel parts, will soon cause oxidation. Now, as the dial house is in close proximity to the factory in which the steel parts are made, the fumes of the acid would be carried to the other manufacturing departments and cause an endless amount of trouble. The device about to be described,

Fig. 50. Temperature Adjusting Cabinets

which was devised by Mr. Charles T. Higginbotham, consulting superintendent, takes care of these acid fumes in a satisfactory manner.

The arrangement consists of a funnel-shaped box through which the acid fumes are blown by means of an electric fan. This funnel-shaped box terminates in another box, where the fumes meet with a fine spray of water which descends in the

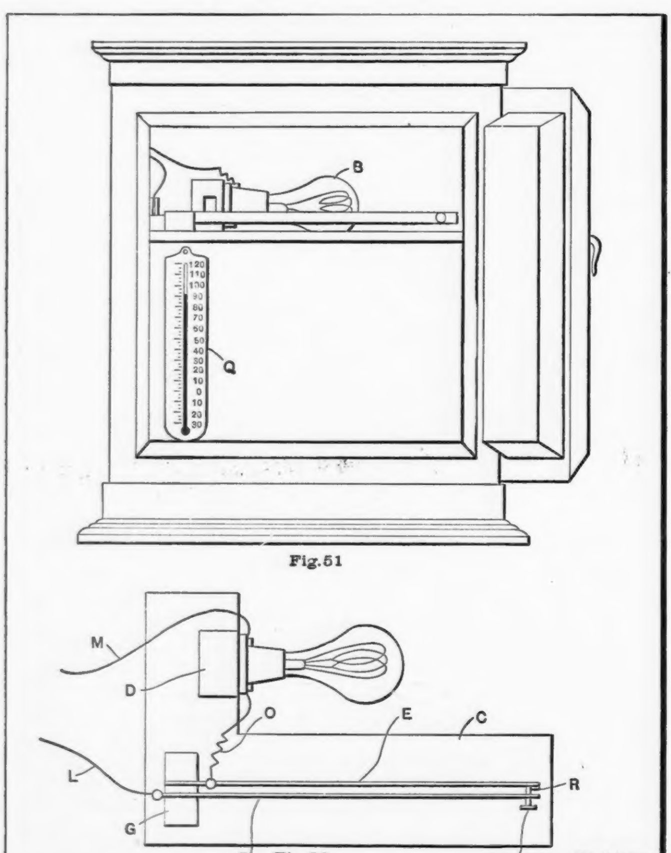


Fig. 51. Interior Arrangement of the Temperature Adjusting Cabinet shown at A in Fig. 50. Fig. 52. Temperature Regulator

shape of a fog, absorbing the nitric acid fumes and carrying them to the sewer.

After burning out a portion of the copper disk, the hole is lapped with a copper lap coated with a putty powder made from oxide of tin. The sunken portion of the dial is then cemented in place with gum arabic and the parts are soldered together. The dials are next coated with shellac varnish to obviate scratching. There are a number of other minor operations on the dials before they are ready to have the characters stamped onto them, such as beveling the edge, drilling cross holes through the dial-foot pins, etc.

Printing the Characters on Watch Dials

The characters which were formerly painted on watch dials by artists are now put on by means of a transfer method, using a steel stamp in a dial printing machine. This machine is shown in Fig. 48, and in detail in Fig. 49. The dial to be printed is placed in a nest *A* held in the table of the machine. The steel stamp *C* fastened to the table has the characters cut in it (not in relief). This stamp is coated with fondant and the excess material removed, leaving the characters filled with the "paint." The operator, by means of handle *D*, now throws in the clutch, indexing the table to bring the steel stamp under the rubber transfer pad *E*, the latter being brought in contact with the stamp by means of a cam. The table is again indexed, bringing the dial under the rubber transfer pad, and the characters are stamped on.

The mixture used as a paint for printing the characters on the dial is composed of black enamel, which has been ground extremely fine and then mixed with oil of thyme. After the dials have been stamped they are coated with "under-glacé" and the dials black-fired. Before this latter operation, however, the dial has received two impressions in the dial print-

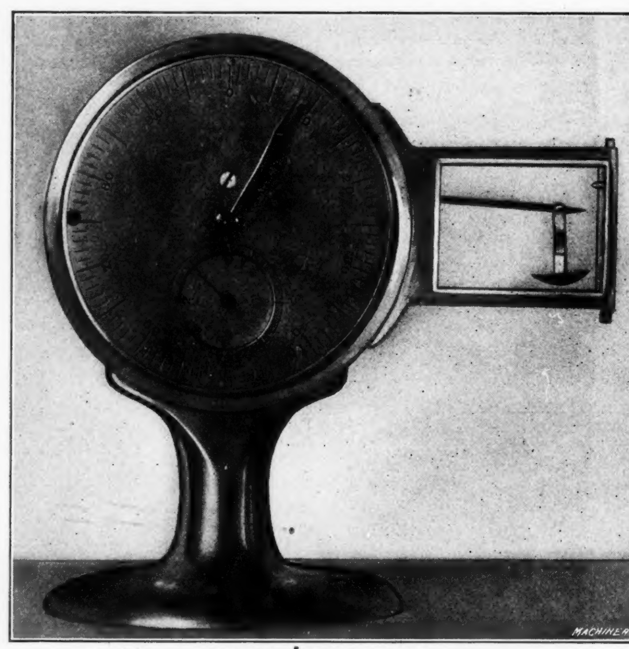


Fig. 53. Scales for Weighing Balance Screws

ing machine, the first impression being allowed to dry before th second one is applied. The black-firing takes place in the gas furnace shown in Fig. 47.

The machine used for printing the characters on the dial has some interesting mechanical features. It consists essentially of a table *B* on which the work and stamp are held. (See Fig. 49). This table is indexed or rotated by means of a sector gear *F* meshing with a pinion *G* keyed to the spindle of the table. An indexing dial *H*, provided with two notches in which an indexing finger fits, locates the table in the two positions. The sector gear receives its motion through bevel gears *I* and a worm and worm-wheel *J*, the latter being driven by pulley *K* belted to the overhead works.

The rubber transfer pad is operated by means of a cam *L* and bell-crank lever *M*, the latter being fulcrumed at *N*. The upper arm of this lever straddles a sleeve *O* which butts against a shoulder on spindle *P*. This spindle has an arm *Q* fastened to its top end carrying an adjustable screw *R* which comes in contact with the upper end of the spindle carrying the rubber pad. Spindle *S* is returned to the "up position" by means of a spring *T* working against collar *U* which is fastened by a set-screw to the spindle.

Assembling and Finishing Operations on Watch Movements

Upon completion, all of the small parts are turned into the stock-room from which they are sent out when needed. When

the jewels have been burnished into their settings, the settings are put into the plates and bridges, and the latter are ready to be assembled with the various parts of the movement. Following this, the hair spring is trued, over-coiled and vibrated for strength. The balance is also trued up and fitted to the staff. Probably one of the most interesting operations performed on a watch movement in its final stages of completion, however, is that of temperature adjustment. After the watch movement has been completely assembled and tested, it is placed in the oven shown at *A* in Fig. 50. This is provided with a water jacket having a capacity of 40 gallons, and is heated by two 4-candlepower bulbs, which keep the water at a temperature of 90 degrees. The water jacket is used as a precautionary measure so that in case the electric current is turned off for a short time there will be no difference in the temperature.

The device used for heating this cabinet and keeping it at a uniform temperature is shown in Figs. 51 and 52. The door is made to fit closely and is provided with a door jamb set at an angle. The electric bulb *B* is wired to the electric circuit and also to the temperature controlling mechanism. This, as shown in Fig. 52, consists of a wooden base *C*, to which a block *D* is fastened to hold the lamp socket. Two bi-metallic bars *E* and *F* are let into a wooden block *G*. These bars are made from a strip of brass ½ inch wide by 0.060 inch thick by 12 inches long, to which a strip of steel 0.040 inch thick is soldered. The wires *L* and *M* lead from the switch of the electric wiring, while wire *O* connects the bar *E* with the lamp. The brass strips on these bars face each other. Contact is made by a platinum tipped adjusting screw *P* that comes in contact with the platinum facing *R* on bar *E*.

This device works on the same principle as a compensated balance. Heat expands the brass strips to a greater extent than it does the steel strips, thus bending the bars outward and breaking the electric circuit by separating the platinum faces. Screw *P* is used to adjust the contact at the proper point, so as to regulate the temperature. A thermometer *Q* is suspended with its bulb near the watches to be tested, so that a true temperature will be recorded. The watch movements are kept in this cabinet at a temperature of 90 degrees F. for 24 hours.

After the movements have been removed from cabinet *A*, Fig. 50, they are placed in the ice box shown at *B*. Here they are left for 24 hours at a temperature of 45 degrees F. They are taken out and the change in time noted. The adjustment for temperature is accomplished by changing the weight of the balance screws, and also their location in the rim, so as to equalize the expansion and contraction of the balance.

Weighing Balance Screws

The scales used for weighing the balance screws are shown in Fig. 53 and in detail in Fig. 54. The dial is provided with 100 graduations, each graduation equaling one ten-millionth of a pound avoirdupois. The lower dial hand registers 1 when the larger hand makes one complete revolution of the dial.

Referring to Fig. 54, it will be seen that this scale consists of a beam *A* pivoted at point *B* on a balance staff *C*, the pivots of which run in jewels. Attached to the staff *C* and to a pin in wheel *D* is a watch hair spring *E*. The main wheel *F* held on arbor *G* rotates the small needle *I*, which makes one complete revolution to every eight revolutions of the large hand *J*.

To weigh a balance screw, the glass door *K* is swung back and the screw deposited in pan *L*. Then the door is closed and the hair spring *E* wound up by means of knurled thumbscrew *M* and pinion *N*, until the tension of the hair spring overcomes the weight of the screw. The screw is then removed from the pan and the door closed, when the hands register the weight of the screw on the dial in ten-millionths of a pound avoirdupois. Flat spring *O* and thread *P* take up the back-lash in the gearing. So sensitive is this scale that the amount of lead deposited on a piece of paper when writing a name with a lead pencil is clearly registered on the dial.

A difference in weight in a pair of screws, located in the rim of the balance, of one ten-millionth of a pound equals a variation of one second an hour in a watch.

Final Inspection

In the making of the South Bend watch movement parts, over twelve thousand separate and distinct operations are required. Over one hundred operations are performed on the dial alone, while the completed watch has passed through four hundred and eleven inspections. After the watch movements have been accurately adjusted and timed they are, as a final test, run for six days in order to insure uniformity of rate. Even after a watch movement has passed through all of these inspections and has been packed ready for shipment it goes to a final inspector, who unpacks the movements and puts them through a final examination for the purpose of reducing to a minimum the chance of any defect.

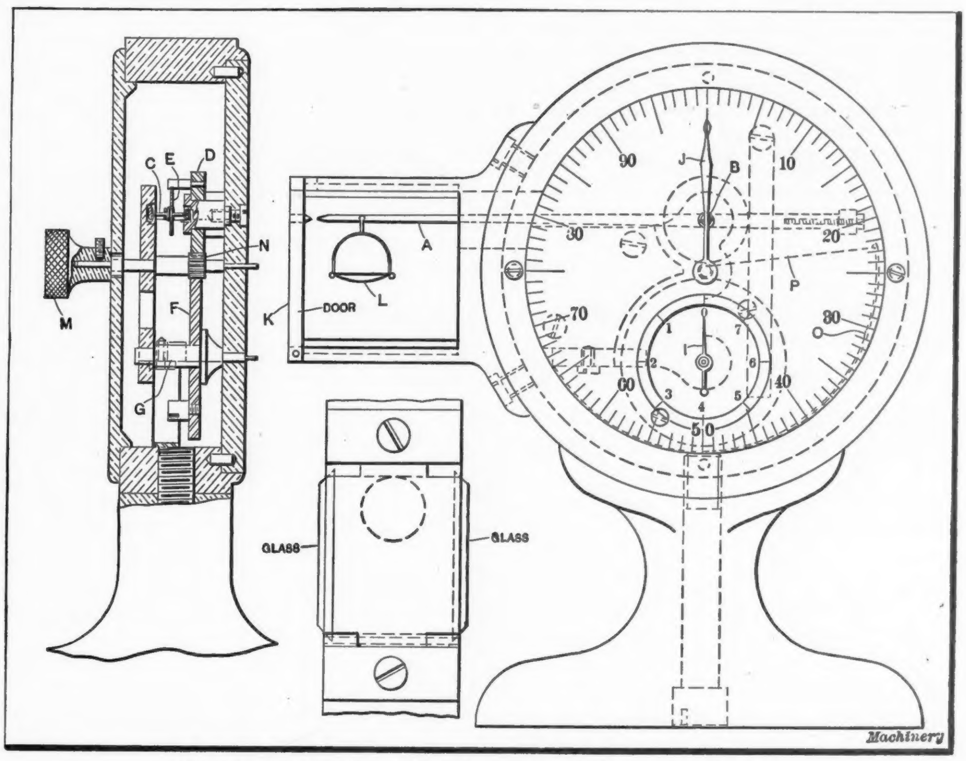


Fig. 54. Construction of the Balance-screw Scale shown in Fig. 53

* * *

A bill framed as a committee measure by the Patents Committee of Congress, and which covers the features of all the different bills that have been brought in during the present session of Congress relating to patent monopolies, contains the following features of special importance: It provides for compulsory licenses, which, however, will not apply to the original inventor, but only to those persons or corporations who acquire patents by purchase, and who in the past have often done so for the purpose of suppressing competition. It also provides that no purchaser, licensee or lessee of a patented article shall be liable for action for infringement of the patent because of breach of any contract of sale or license. The bill does not propose to take away any right of action, so far as the contract is concerned, but it does take away the rights that may now exist to bring an infringement suit growing out of a contract with regard to the use or sale of a patented article. It also proposes to so amend the Sherman anti-trust law as to make it clearly applicable to combinations and trusts in restraint of trade where patents are involved in the monopoly.

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THE REVIVAL OF BUSINESS

The fall season has opened with a heavy increase of business in iron and steel products, machine tools, accessories and kindred lines required in manufacturing, which makes the outlook bright; but the tendency to mark up prices higher than conditions warrant is a mistaken policy that will inevitably result in a setback.

The crops are large and the railroads have more freight than they can move, and there is already a car shortage which is likely to increase to serious proportions. So marked a revival of trade in a presidential election year is a phenomenon almost unequaled. The common notion that business must be dull every four years apparently has been exploded, and we sincerely hope that the quadrennial scare incident to the presidential election has been dispelled.

America's resources are too great and its business is based on too solid a foundation to be seriously disturbed by possible or impending changes in the political complexion of the government. Changes in economic policy are inevitable, and whatever the coming readjustment of the tariff schedule may be—for readjustment there will be, in some respects, whoever is elected—these changes will be made conservatively and with due regard to the welfare of the great industries that have developed during the past fifty years under a protective tariff.

* * *

THE TESTING OF MATERIALS

When speaking of the testing of materials for construction, one generally understands merely the testing, by suitable machines or other means, of the various qualities of a material. The scope of the work of the International Association for Testing Materials, however, is much greater than implied by this narrow definition of the testing of materials. It is recognized that it would be of little or no use, though we were ever so expert in the mere testing of materials, if we did not at the same time know exactly what was required of certain materials for certain service. We may, for example, be able to test the tensile strength, elastic limit, hardness, elongation etc., of the material entering into steel rails, but the information thus obtained would be of comparatively little value did we not at the same time know, with certainty, the requirements necessary for steel rails that have to stand the pounding of heavy engines on a sharp curve at high speeds. It is the object of the men interested in the testing of materials not only to devise means for carrying out the required tests, but also to settle upon the necessary specifications for materials to be used for different purposes, and to aid the makers of these materials, if possible, in obtaining the required qualities in them. The scope of the International Association for Testing Materials, therefore, is a very wide one. It embraces in its final analysis not only that part of the engineering science which deals directly with the study of materials, but also that which enters into the fields of design and manufacture. The work of the association is highly important to the engineering world, and the sixth congress of the association, held in New York City during the early part of September, tended to emphasize this fact. The great number of papers presented indicated the activity of the members, and the engineering world, in general, is to be congratulated upon the effective work being done.

* * *

MECHANICAL EFFICIENCY

The theory of the efficiency of machines is one of the simplest in applied mechanics, but it nevertheless seems to be one very often misunderstood and misapplied. The hundreds of inventors of perpetual motion machines are notorious examples of those who misunderstand it and the great principle of conservation of energy, but they may be classed as impractical men of little or no importance in the machine building world. There is another large class, however, whose ideas are embodied in machines built, sold and used with various degrees of satisfaction who are more or less hazy on certain fundamental principles. It is important that this class thoroughly understand the general principles which conserve power, reduce wear, and tend generally to promote the life and efficiency of machines.

A machine may be effective without being mechanically efficient, and again it may be mechanically efficient without being effective. This is an apparent paradox generally understood and appreciated. A worm-gear, as ordinarily made, is effective but not efficient, and on the other hand if highly efficient it fails to be effective as a brake—a most important consideration in some machines. In the case of machine tools, mechanical efficiency is ordinarily regarded as a minor matter, while accuracy, convenience of operation, adaptability, safety and pleasing lines are of paramount importance. But mechanical efficiency, aside from power saving, is important, nevertheless, as a mechanically inefficient machine wears rapidly and requires more lubrication to do its work than the efficient machine.

The efficiency of a machine is measured by the percentage of useful work available after transformation in the machine. The percentage of useful work is always less than one-hundred, is rarely over ninety-five in the simplest mechanisms, and is often less than ten. Efficiency is expressed by the formula: $E = \frac{W - w}{W}$, in which E is efficiency; W, the work put in; and w, the work delivered.

A stiff machine in which the train of mechanism is well supported is more efficient, other things being equal, than one having a weak and flexible train. Work is lost in bending the parts, especially when the action is intermittent. A reciprocating motion may be transmitted, for example, through a lever so weak and flexible that all the work put into the machine is lost in deflecting this member, thus producing molecular distortion and heat. Take, for example, a compressed air riveting machine of the alligator type. The stiffness of the levers is an important factor in its efficiency. A riveter having ample cylinder capacity might, nevertheless, be so weak in the levers that the toggle action would fail to produce the squeeze necessary to upset the rivets. The work that should be expended on the rivets is lost in friction of the pivots and in springing the levers which yield at the critical position so much that the necessary force to upset them is not developed. This machine would use as much compressed air as another of the same size but with stiffer mechanism which would effectively set the rivets. One is efficient and the other is totally inefficient.

Hence mechanical efficiency, while meaning the percentage of power available in terms of the power expended on a machine, should also mean that the machine is so designed that its parts are subjected to minimum wear, that a minimum amount of oil is required for lubrication and that no part is subjected to such high bending stresses at any point that it bends appreciably when transmitting the load required to do its work effectively.

* * *

SQUARE AND HEXAGON SOCKETS

The analysis of the stresses acting in square and hexagon socket safety set-screws by Mr. Myers in another part of this number, is an excellent example of practical application of mathematics to design. This is a case in which the strength of two members should be equal, if possible, but the proportions necessary for equal strength cannot be determined by simply adding here and taking off there. While the analysis is not rigid, it is sufficiently complete to answer practical requirements. It shows how the wrench socket may be so proportioned as to secure the maximum strength for both the wrench and the screw. Of paramount importance is the matter of durability when the hollow screw is employed for lathe chucks and other parts requiring constant manipulation. While it is shown that for pulley hubs and other machine parts the hexagon socket set-screw is best, as it can be so proportioned as to have greater strength than square socket set-screws of the same size, it is also shown that the square socket is better adapted for those situations in which it is subjected to daily use. Hence for lathe chucks, drill chucks, lathe dogs, etc., the square socket is preferable.

The superiority of this method of determining proportions of machine parts over mere guesswork and numerous tests is obvious. Tests, of course, are necessary to verify conclusions and make certain that the minor factors neglected in calculations are not of greater importance than assumed, but a comparatively small number of tests will suffice to verify a rational design; whereas, with rule-of-thumb or guesswork design those proportions necessary for maximum strength and efficiency are usually found only by a slow and costly process.

* * *

TABLES AND DIAGRAMS

There is considerable difference of opinion among mechanical men regarding the relative advantages and uses of tables and diagrams for recording data. Some engineers seem to prefer to tabulate all data coming under their observation, which may be useful in their practice, regardless of the fact that much of this information could be more conveniently shown in diagrams. Others have what might be called the diagram hobby, and apparently believe that all mechanical data that can possibly be given in diagram form should be put in that shape.

Both of these extreme types show a lack of appreciation of the true uses of tables and diagrams. There is, in general, a fairly well-defined field for each, and engineering data should be recorded partly by tables and partly by diagrams, according to which form best meets the requirements of the practical man. Whenever the matter dealt with has to do with parts, devices and objects made in certain specified sizes, once standardized, a table is most convenient. As an example, may be mentioned data relating to tap drills and other dimensions required in the use of pipe taps. Here a diagram is of little or no value, as there are but comparatively few standard pipe tap sizes, and all the dimensions relating to each of these sizes can be easily and conveniently tabulated with much greater exactitude than they could be put in diagram form; at the same time the chance of error in using a table is far less than in reading off a dimension from a diagram. The diagram, again, is most useful in cases where an indefinite number of combinations of values may exist, and where curves may be used to indicate the values to be found for any combination. An example of this kind is a horsepower diagram from which the horsepower that may be transmitted by gearing of different pitches and velocities may be found. In this case, tables would be entirely too voluminous, and could hardly contain all the possible combinations covered by a diagram of comparatively simple construction.

In a general way, therefore, the proper place for a table is where certain definite data are known and fixed and the values to be found corresponding to them can be conveniently put in plain figures. The diagram should be used instead in all cases where a great number of different combinations of two or more initial values are given, and where a tabulation would be entirely too voluminous to be practicable, both because of the time required for compilation and the inconvenience incident to its use. The diagram has in some cases another advantage—a curve may show the trend of certain functions, indicating the rising or falling values under certain conditions, etc. In this case, the diagram is especially useful in investigating work, when making tests, or when comparing the relative efficiency of mechanisms.

* * *

THE ONE HE GOT FROM HOME

BY A. P. PRESS

Bill was a first-class toolmaker, one of the very best we had in the shop, and the only fault we had to find with him was that nothing he ever did or saw us do—in fact, nothing in the shop or even in the whole country was so good as what they did "back home." What they did "back home" according to Bill's tell was certainly a wonder.

One day he got to talking to the boss patternmaker about extension bits.

"I tell you what, the extension bits we have 'back home' are way ahead of anything that you can get in this country, and the next time any of the boys go 'home' I am going to send and get one for you. I'm willing to pay for the bit, just to show you what they make over there."

Two weeks after that one of the boys in the shop made up his mind to take a trip to the old country, and when he came into the shop, after he got his ticket, Bill put it up to him to get him (Bill) an extension bit.

"Buy me the very best extension bit you can find, no matter what you pay for it, or who makes it, and bring it back when you come, and I will make it right with you."

"All right," and off he went.

Two months passed by, and one day he came in and asked for his old job, and as he was a "crackerjack" good man, we were glad to get him, and told him to come in in the morning.

When he came in the next day he brought in Bill's extension bit. It was in a box the same as they make "back home," and what it said on the label we are unable to tell as we only read and speak one language.

"There," said Bill, as he proudly took it out of the case, "there's a bit that is a bit. Look at that finish, and look at the way the blade is held in on the end."

"Say, but that is pretty good," said the boss patternmaker, "but at the same time it looks kind of familiar. What name is that on the shank? Hold on a minute. I can read that. Why that was made by the S. S. & S. Co., right up here in the next town."

"Well, Bill," said the boss patternmaker, "I want to thank you for that bit. Never mind if it was made only ten miles away, it has been to the old country and back again, and that is more than I ever expect to do, and I shall treasure it all the more for that."

This was the last of anything that we ever heard about "back home."

* * *

According to *The Foundry*, experiments have been made by the Crane Co., Chicago, Ill., which have shown that if iron borings are used in place of a portion of the gravel mixed in concrete, floors of this material can be successfully used in certain portions of foundries. Many foundrymen are interested in the use of concrete floors, but have generally found them unsatisfactory because molten iron will not lie on concrete on account of its porous and, therefore, generally moist condition. The mixture recommended consists of one part cement, three parts sand, four parts gravel, and one part of iron borings. It is stated that floors made from this mixture are perfectly safe.

CASEHARDENING AND CASEHARDENING PRACTICE*

A REVIEW OF METHODS IN THE BICYCLE, AUTOMOBILE BUILDING AND ALLIED TRADES

BY ROBERT H. GRANT†

A great improvement has been made in casehardening processes during the last few years. The advance was begun with the development of the bicycle industry, and the necessity for casehardened parts of the highest quality in automobile manufacture has been the cause of still further improvements in this field.

As an example of what can be accomplished by proper methods, consider the transmission gearing of an automobile. Who would think of throwing in the back-gears of a lathe or any other machine tool without first stopping the machine? In an automobile, however, this very thing is actually done, perhaps a hundred times a day, by a person who gives little thought to what he is really doing. Yet the gears stand up under this treatment because of being manufactured from special steels developed during comparatively recent years, and because of being heat-treated and casehardened by improved methods.

Principles of Casehardening

Casehardening is actually only an improvement on the old cementation process used in times past for making steel from wrought-iron. This process consisted of rolling the wrought-iron into thin strips and then placing it in boxes with some material containing a fair portion of carbon. These boxes were then heated to a very high temperature and the carbon was gradually absorbed by the iron.

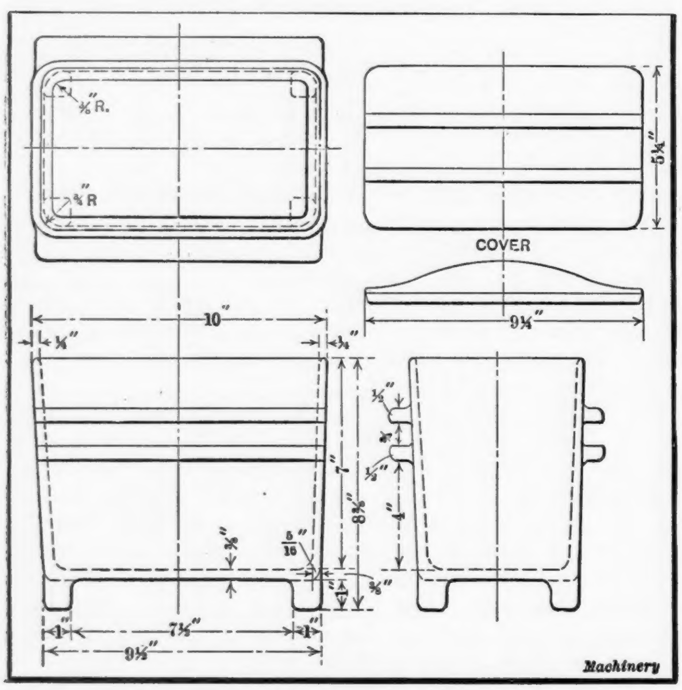

Fig. 1. Box for Casehardening, of Approved Design

In modern casehardening there are a number of different questions that must be taken into consideration. In the first place, the steel or material to be used must be considered. Another most essential thing is the casehardening furnace which must give a uniform heat. As oil has almost wholly superseded coal for heating casehardening furnaces, the changes in furnace construction have, of late, been considerable. The box constitutes another item which must be considered, as well as the material used in packing the parts to be casehardened. The methods used for hardening the parts after they have been carbonized is another question that must be dealt with.

Steel to be used for Casehardened Parts

As the casehardening process consists in adding carbon to the steel, it is necessary to use a material which will absorb the carbon without necessitating overheating or burning. The effect of carbon on steel is, in general, it may be said, to make it dense, and the denser the steel, the higher the heat necessary to open the pores through which it must absorb the carbon. A low carbon steel containing say from 0.15 to 0.20 per cent of carbon is, therefore, most suitable for casehardening. It should also be borne in mind when selecting the material that the casehardening process does not eliminate any of the impurities ordinarily found in iron, such as sulphur, phosphorus, etc., and hence a material as free as possible from these impurities should be selected.

Furnaces for Casehardening

In building or constructing a furnace for casehardening, the size of the work to be hardened should be the first consideration. It is far better to use a small furnace with a small box whenever possible. If the work varies in size, different sizes of furnaces may be used. Small furnaces require less fuel, and small work must be placed in small boxes as otherwise the pieces packed near the sides will be overheated while those in the center will not reach the required temperature. The furnaces should be made right- and left-hand so that they can be placed close together. Thick walls should be used to retain the heat. These walls should be supported by a substantial concrete foundation, so that they will retain their position and shape, even when subjected to a high heat. Large flues should be provided to carry away the smoke and gases.

The furnace should also be so constructed that as much as possible of the heat of the combustion gases may be extracted before they are discharged. The flues and all parts of the furnace should be easily accessible, and a door, the full width of the oven, should be provided so that the tiles can be taken out and the flues cleaned. A pressure blower with a light oil should be used with all the pipes accessible and placed, preferably, above the furnace. If, however, they are placed below ground, they should be arranged in compartments which can be easily reached if repairs are required.

The blower pipes should be run through the furnace so as to preheat the air used; if cold air is used directly it will reduce the heat in the furnace. The furnace fronts should be made in several parts to prevent cracking, with the door properly balanced and lined. A shelf should be provided, projecting at the front, for holding the boxes when they are taken out or put into the furnace. The smokestack should be made of sufficient height to produce a good draft.

Burners should be placed both at the front and rear of the oven and should be arranged in separate compartments, so that the heat will be uniform in the oven. The hot gases will then pass over the top of the compartment wall and strike the boxes on the top, after which they pass out through small openings in the corner of the furnace. They then take a zigzag course under the tiles and pass from there through a flue to the rear of the furnace. A large conduit should be provided just below the ground which will catch all the soot. This conduit should be provided with iron covers which can easily be taken off to remove the accumulation of soot.

The furnace should not be heated too quickly, as this is apt to crack the brickwork. The cooling should also be done gradually. After the work has been taken out and the heat shut off for the day, all the dampers should be closed to hold the heat. In this way the furnace will cool slowly and cracking or bulging out of shape will be prevented. In addition, it will be easier to heat the furnace the next morning, as it will have retained some of the heat.

When work is to be annealed, it should be placed in the furnace after the work to be hardened has been removed, and then the furnace brought to the proper heat. The ma-

* See also the following articles previously published in MACHINERY: "Casehardening," August, 1905, engineering edition; "The Casehardening Furnace," June, 1907, engineering edition, and the articles there referred to; "Casehardening Practice at the Juniata Shops of the Pennsylvania Railroad," July, 1910, engineering edition; "New Casehardening Methods," February, 1912, engineering edition; "Casehardening Temperatures," July, 1912, engineering edition. See also MACHINERY'S Reference Book No. 63, "Heat Treatment of Steel."

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terial to be annealed can then remain in the furnace until the next morning with the furnace closed up and the burners turned off.

A light oil should be used. It should have a high heating value and be comparatively free from carbon deposits, etc.

Boxes for Casehardening

The boxes for casehardening should not be made larger than necessary for the class of work being handled. They should be made from a malleable iron, as ordinary cast-iron boxes are not suitable on account of the fact that they are very porous and absorb the carbon of the carbonizing material. The boxes should also be provided with feet, as shown in Fig. 1, so that the heat can circulate all around them. The covers should be provided with ribs on the top to prevent excessive warping, and the sides should be ribbed so that a fork or grapple iron, as shown in Fig. 2, can be used for handling the boxes. The sides of the boxes should taper slightly towards the bottom so that the contents can be easily dumped out of them; they are also easier to cast when made in that way.

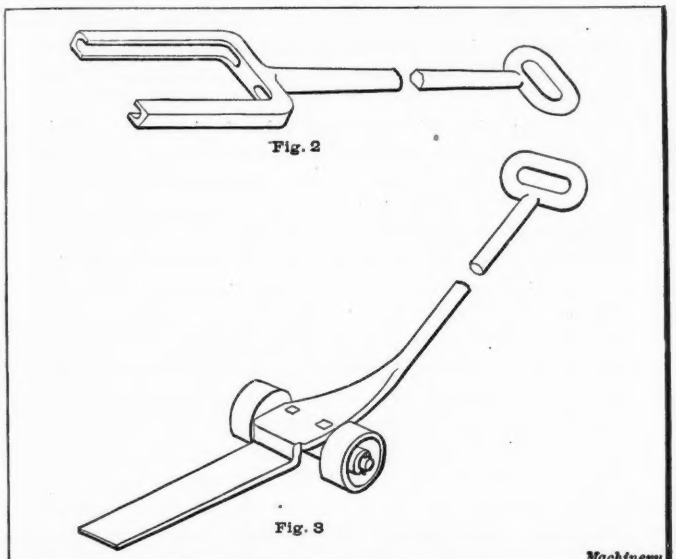


Fig. 2. Grapple Iron or Fork used for Handling Casehardening Boxes. Fig. 3. Truck for Handling Heavy Boxes

When very large boxes are required, they should, if possible, be provided with a hole through the center so that the heat can reach the contents from the inside, as well as from the outside. A box of this kind is shown in Fig. 4. For long work, such as shafts, tubing, etc., a wrought-iron pipe with a cap on each end provides an ideal box.

Local Hardening

In many cases it is essential that the piece of work be hardened at a certain place and that other parts be left soft. There are three ways in which this can be accomplished: First, by copper-plating and enameling; second, by covering the part which is not to be hardened by fire clay; and third, by using a bushing or collar to cover the part to be left soft.

In the first case the article should be painted with enamel where it is to be hardened, the enamel being baked after having been applied. The remainder of the piece that is to be left soft is copper-plated. In the second case, if the article to be hardened has a recess, such as a hole, slot, etc., this may be filled with clay. The third method is used when a shaft, for example, is only to be left soft for a short distance. A collar is then placed on the shaft, and this provides the easiest and least expensive means for accomplishing the purpose.

In the case where enamel and copper-plating is used, the enamel will burn away and allow the surface covered by it to absorb carbon and, hence, to be hardened, whereas the copper will stand a very high heat and prevent hardening of those portions that are covered by it. If the copper is burned off, it is an indication that the work has been overheated. The clay prevents the hardening of a portion of the work in the same way as does the copper. It is also of advantage when dipping the work, as it prevents the formation of steam pockets which are apt to warp or distort the piece. When a sleeve or collar is used, this should be made about one-half inch longer than the part which is to be left soft, so as to prevent carbonization near the ends of the collar.

Packing for Hardening

The packing room should, if possible, be separate from the room containing the furnaces, so that the packing can be done without the discomfort of the heat and dust. Tables on wheels, or trucks, provided with shelves of the same height as the shelf in front of the furnace and large enough to hold the required number of boxes for one furnace, should be provided, so that the packed boxes can be easily moved to the furnace and quickly placed in it. The work to be hardened should be classified according to its size and the percentage of carbon required, as it will take a higher heat for larger work, as well as for pieces which are required to absorb a higher percentage of carbon.

There are a great many different kinds of hardening materials, but the old-fashioned method of using ground bone can always be relied upon to give satisfactory results. During the last few years, however, the use of bone in various manufactures has increased so that the price of ground bone for casehardening purposes is almost prohibitive. Leather has become very extensively used for this purpose, it being first burned and then ground and graded.

A mixing bin is a great advantage in connection with the handling of the casehardening material. Some partly used bone and some new is then used to make a mixture suitable for the size of the pieces to be hardened. Large pieces require a richer material than smaller ones, as during the higher heat required for the larger pieces and the longer application of the heat, more of the carbonizing material will burn away.

When packing a box, first put a layer of the casehardening material on the bottom, the thickness of this layer depending upon the size of the pieces to be hardened. If the articles are heavy, they do not require such great care in packing, but if they are thin or long, or have a peculiar shape, greater care is required. It has frequently been stated that one piece should never be permitted to touch another when packing, but it has been found that this precaution is not necessary. If a box is properly sealed, the parts can touch each other without injury. Thin long pieces should, if possible, be placed in an upright position to prevent their sagging out of shape. Between each layer of pieces, casehardening material is packed according to the size of the pieces to be hardened. It has been found from experience that if there is not enough

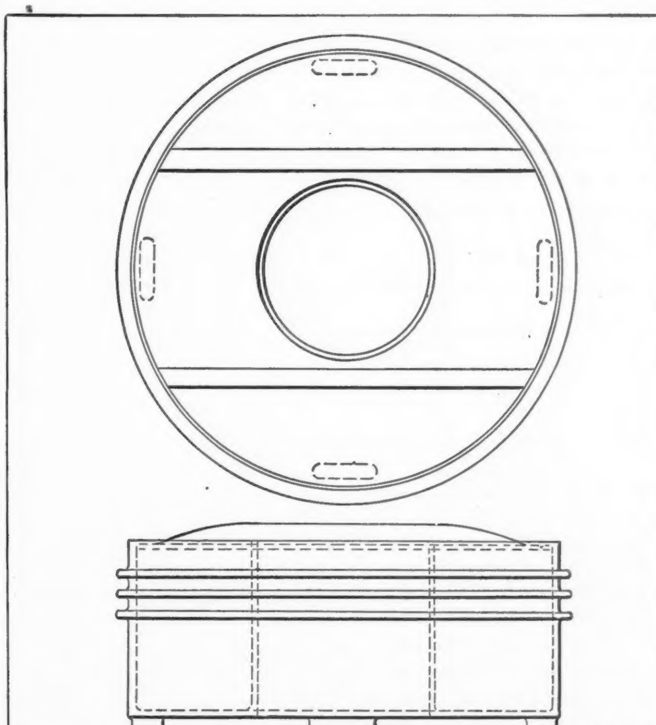


Fig. 4. Large Circular Box with Hole in Center for the Circulation of the Gases of Combustion

of the carbonizing material in the box, the work is liable to have soft spots.

About two inches from the top of the box, sheet steel strips about 1/16 inch thick should be laid and these should be covered with a layer of about one inch or more of powdered charcoal. Then the cover is placed on the box and the edges are sealed with fire clay. If there is any doubt about the length of time required for heating the pieces to obtain a certain depth of case, wire a couple of pieces together, allowing the wire to project out of the box. These pieces can then be taken out quickly and hardened, and, in this way, it can be ascertained whether the parts have been sufficiently carbonized. In casehardening very small work, it is advisable to wire the pieces together so that they can be taken out of the box at once; otherwise, they would have to be picked out with small tongs, as it is impossible to sift very small work in a screen because the mesh would have to be so fine that it would take a long time to do the sifting and the work

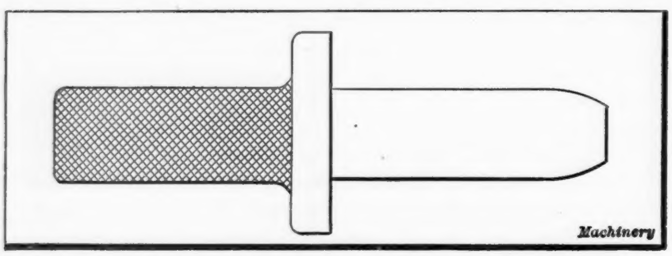


Fig. 5. Mandrel used when Hardening Collars, etc., on the Outside

would become too cold for hardening. If it is desirable to color the work, from one-third to one-half of the carbonizing material should be burnt leather.

The boxes should never be put into the furnace under a high heat, but should be placed in it when its temperature is from 800 to 900 degrees F. Then the heat should be slowly brought up to from 1500 to 1800 degrees F. In placing the boxes in the furnace, great care should be taken that the hot gases have an opportunity to circulate all around them. A pyrometer should be put in some convenient place and properly wired so that the heat in the furnace can be readily ascertained at any time. If there is a great deal of night work to be done, a recording pyrometer should be used as it gives the man in charge a record of the heats during the night.

By the aid of the pyrometer it has been found that it is necessary to have an expansion tank in order to get a con-

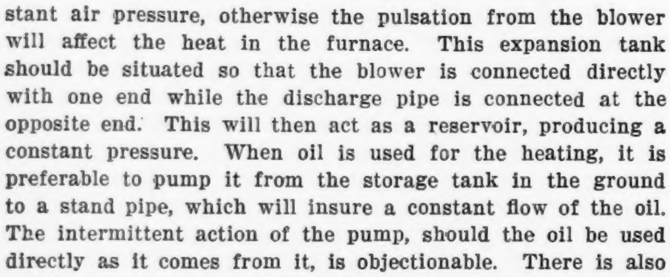


Fig. 6. Holder for Parts which are to be hardened locally

stant air pressure, otherwise the pulsation from the blower will affect the heat in the furnace. This expansion tank should be situated so that the blower is connected directly with one end while the discharge pipe is connected at the opposite end. This will then act as a reservoir, producing a constant pressure. When oil is used for the heating, it is preferable to pump it from the storage tank in the ground to a stand pipe, which will insure a constant flow of the oil. The intermittent action of the pump, should the oil be used directly as it comes from it, is objectionable. There is also another advantage, in case the pump should have to be shut down on account of break-down. In that case, the furnaces could still continue to operate, as the stand pipe should hold a supply of oil sufficient for several hours. At night and on holidays the oil should be drained back into the storage tank in order to minimize the danger incident to its use.

The supply pipe for the air should come from the outside and should be so arranged that the air passes through a fine wire netting, so as to prevent foreign substances from entering the blower.

On the outside of each furnace a card should be placed telling the kind of work that is in the furnace, when the work was put in, the heat required for it, and when it is to be removed. These cards can be kept as a record which will be of value when comparison is made with the depth of case obtained under any specific conditions.

Carbonizing, Reheating and Hardening

The heat required for casehardening is a great deal higher than that required for ordinary hardening. If, for example, the material to be casehardened was heated only to 1375 degrees F., which would be sufficient for the hardening of ordinary tool steel, the result would be very unsatisfactory. In fact, there would be no result at all. Small parts must be heated to at least 1575 degrees F., in which case sufficient depth of carbonized surface will be obtained in from six to eight hours. The time recorded as the correct one for casehardening should be taken from the time the boxes are heated clear through.

The correct way in which to caseharden is first to carbonize the material and then to allow the boxes to cool down with the work in them, after which they are reheated and hardened in water. The reheating refines the grain of the steel and prevents the formation of a distinct line between the outer hardened case and the soft core. If there is a distinct line between these two sections, the case is liable to flake off when the hardened part is subjected to severe stresses.

A still more refined method of casehardening is to repack the work, after it has been carbonized, in old bone, and after heating for two or three hours take it out and dip the pieces in the hardening tank directly as they come from the boxes. This will produce a very fine grain and in many cases prevent warping. If the work is large and it is required to toughen the inner core, it should be reheated to a higher heat than otherwise; then, after dipping, reheat again to 1500 or 1600 degrees F. according to the size of the work, and redip.

However, if the work to be hardened consists of bolts, nuts, screws, etc., it is satisfactory to dump them into water directly from the furnaces, without any reheating. A regular iron wheelbarrow with two pieces of flat iron placed across it lengthwise should be provided. On top of these bars is placed a sieve made from 1/8-inch wire with 1/4-inch mesh, about 18 inches square by 6 inches deep. This sieve should have a handle 6 feet long and 5/8 inch in diameter. The boxes are emptied into this sieve, and after sifting, the heated material is dumped into a tank of cold water which should be of sufficient size to prevent the water from heating too quickly. Care should also be taken in emptying the contents of the boxes into the water that they are not all dumped in one place, but scattered about in the tank. A constant flow of water should be available while the work is being hardened. The work should under no circumstances be removed from the furnace until the heat has been lowered, as the steel should be treated as tool steel after it is carbonized, and it would be injurious to the steel to harden it at the high carbonizing heat.

Gears and other parts which should be tough, but not glass hard, should preferably be hardened in an oil bath. There is then less liability of warping the work, and the hardened product will stand shocks and severe stresses without breakage. Cotton-seed oil is the best hardening medium to be used in this case.

After the work has been properly carbonized, the next operation in the case of all parts, except those mentioned as exceptions above, is to reheat. This may be done either as already explained, or it may be done in a regular muffle gas furnace in which the work can be put in rows on the tile. In this way the work can be heated very slowly, a new piece being put into the furnace to take the place of each piece as it is removed. Collars, etc., which are required to be hardened on the outside, but ought to be left soft on the inside, should be hardened on a mandrel, such as shown in Fig. 5, the diameter of the mandrel being from 0.001 to 0.003 inch smaller than the hole in the piece to be hardened. If the

inside of the piece only needs to be hardened and the outside should be left soft, a cup-shaped holder, such as shown by the dash-dotted lines in Fig. 6, may be used. In this case the work will harden at *B* while it is left soft at *A* and *C*.

The hardening tank should be about 30 inches in diameter and 36 inches deep and have a constant flow of water from a pipe in the center about 6 inches below the surface.

Straightening the Work after Hardening

On account of the manner in which steel is rolled, drawn or forged, the density varies in different parts of the steel, and no matter whether the material is heat-treated or not, it will warp more or less when hardened. It is, therefore, necessary to provide apparatus for straightening the work. In straightening, it is necessary to bend the work about twice as much as would be required to merely keep it straight while the pressure is applied, as, on account of its elasticity, it will have a tendency to work back to its original form. Small rollers and shafts can best be straightened in a vise by having a three-point contact on the jaws. For large diameters a special straightener will be required. A surface plate placed to the height of a man's eye, and at a slight angle towards the light, provides the easiest means for testing work of this character while being straightened.

When there is a large quantity of rings to be straightened or trued up, a surface plate can be readily rigged up in the following manner: A solid strap is provided on one side and a compound lever on the other, adjustable to any place along the plate by means of a slot in the latter. By a slight movement of the lever the ring can be trued up. An indicator should be placed at the front of the plate so that the operator can try a ring to see at which points the ring is out, and also the amount necessary for making it round. In straightening washers or flat pieces of any kind, the hydraulic press provides the best possible means. It might be well to mention that washers or flat pieces should be ground by taking a small amount off each side alternately, as, otherwise, they will return to their original warped shape. Another precaution, relating to the grinding of cylindrical surfaces, is to use a copious supply of water, as otherwise the heat of the grinding operation will draw the surface, producing soft spots. These will appear to have been caused by improper casehardening, but as a matter of fact, they are wholly produced during the grinding operation.

* * *

ITALIAN NATIONAL AERO LEAGUE

A national "Aero League" has been formed in Italy and the raising of funds by public voluntary subscriptions has been started to build an aerial fleet of one hundred aeroplanes for the Italian government. A similar movement for collecting, by voluntary subscriptions, funds for the building of military airships has also been started in France; and the extent to which the military craze carries some of the European countries is further exemplified by the fact that in Sweden voluntary subscriptions are now being solicited for the building of battleships. A curious thing is that these movements meet with enthusiastic response, and that in Sweden, for example, millions of dollars have been collected within the space of a few months.

* * *

LIMITS ON GEARING

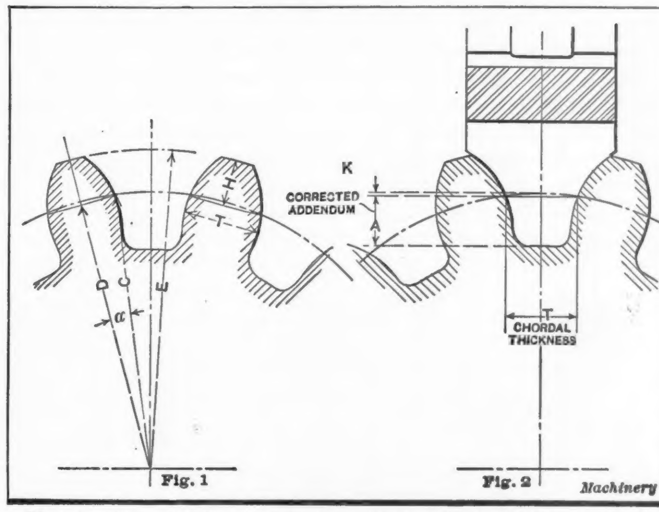
In an article in the *Machine Tool Engineer*, a supplement to the *Practical Engineer* (London, England), Mr. Francis W. Shaw gives the following table for allowable limits for spur gearing, the limits being based on the pitch of the gears:

Pitch	Center Distance	Pitch Diameter	Blanks, Outside Diameter
16	±0.002	−0.003 to −0.005	0.000 to −0.005
14	±0.003	−0.004 to −0.006	0.000 to −0.005
12	±0.0035	−0.0045 to −0.007	0.000 to −0.006
10	±0.004	−0.005 to −0.008	0.000 to −0.006
8	±0.005	−0.006 to −0.009	0.000 to −0.007
6	±0.006	−0.007 to −0.010	0.000 to −0.008
5	±0.007	−0.008 to −0.011	0.000 to −0.010
4	±0.008	−0.009 to −0.012	0.000 to −0.015

CHORDAL THICKNESSES AND ADDENDA FOR GEAR TEETH AND GEAR CUTTERS*

In measuring the thickness of gear teeth and gear cutters, it is necessary to make allowance for the curve of the pitch circle of the gear. In the ordinary 14½-degree involute system, eight cutters to a set are used, the cutters being laid out as follows: No. 1, for 135 teeth; No. 2, for 55 teeth; No. 3, for 35 teeth; No. 4, for 26 teeth; No. 5, for 21 teeth; No. 6, for 17 teeth; No. 7, for 14 teeth, and No. 8, for 12 teeth.

In the following article will be given formulas for finding the chordal thicknesses and what is called the "corrected" addenda, that is, the perpendicular distance from the chord at the pitch circle to the outside diameter of the gear as indicated at *H*, in Fig. 1. In the accompanying Data Sheet



Figs. 1 and 2. Notation used in Formulas for Chordal Thicknesses and Addenda of Gear Teeth and Cutters

Supplement, tables are given for the chordal thicknesses and the corrected addenda for gear teeth and gear cutters. Let,

α = half the angle subtended from the center of the gear by one gear tooth (see Fig. 1),

N = number of teeth in gear,

T = chordal thickness of tooth at pitch line,

D = perpendicular distance from chord T to center of gear,

H = perpendicular distance from chord to outside circumference of gear,

C = radius of gear at pitch line,

E = outside radius of gear.

The formulas are as follows:

$$\alpha = \frac{90^\circ}{N}; \quad T = 2\,C \times \sin \alpha;$$

$$D = \sqrt{C^2 - (\tfrac{1}{2}\,T)^2}; \quad H = E - D.$$

In the case of the gear cutter (see Fig. 2), the chordal thickness is the same as that for the gear, but the corrected addendum of the gear cutter is different from the corrected addendum of the gear. The two dimensions, however, added together must equal the total depth of the gear tooth. To obtain the corrected addendum *A* of the gear cutter, we can, therefore, either subtract the dimension *H*, as found by the previous formulas, from the dimension for the total depth of the tooth, or we can take the dedendum for the particular pitch required from any standard table of gear tooth parts and subtract the dimension *K*, Fig. 2, which is found by the formula:

$$K = C\,(1 - \cos \alpha).$$

The values thus found are given in the tables entitled "Chordal Thicknesses and Addenda for Gear Cutters" in the accompanying Data Sheet Supplement. As these tables are calculated for both diametral and circular pitch and for all commonly occurring pitches in either system, they should prove of considerable value to persons engaged in gear cutting or in the making of gear cutters.

* * *

Rivets should never be used in direct tension, but bolts and nuts should be used instead.

* With Data Sheet Supplement.

PRE-HEATING METALS TO BE WELDED BY OXY-ACETYLENE PROCESS*†

OBJECT OF PRE-HEATING, AND METHODS AND APPLIANCES USED IN THIS WORK

BY J. F. SPRINGER‡

The use of the oxy-acetylene torch for heating the work from the ordinary open-air or room temperature to that of, say, red heat, is a rather wasteful method. It is frequently more economical to do this pre-heating by some cheaper method and then to complete the heating with the torch. Various methods are used for pre-heating; as a rule these methods are comparatively simple. A number of examples will be described in the following.

In pre-heating a large cast-iron kettle, a charcoal fire was employed. The kettle weighed about 18,000 pounds and the metal around the crack, which was about two feet long, was several inches thick. The crack was in the bottom and so the kettle was overturned in order to make the crack more easily accessible. The pre-heating was then done from within the kettle, and, in this case, was not only economical but probably essential, as it would have been difficult to obtain the required amount of heat by the torch flame alone. Asbestos sheeting was employed to protect the operator from the heat radiation.

In repairing a break in a locomotive cylinder, Fig. 1, the pre-heating was also done with charcoal, a temporary oven having been built up of loosely laid bricks, as shown in Fig. 2. The fire was kept going for two and one-half hours, at which time a dull red heat was secured. This condition was maintained for six hours longer during the welding operation. It is often possible to use an ordinary blacksmith's forge for the pre-heating, and if a great many similar parts are to be handled, a special forge and bellows may be found of advantage. In addition to the use of charcoal, torches using illuminating, producer, or natural gas, oil, or gasoline, may be employed; in fact, any method for obtaining a large amount of heat, but not necessarily a high temperature, can be employed. In one case, in welding a break in a locomotive engine frame, a gasoline torch was employed for the pre-heating, the torch being applied throughout the welding operation. In cases of repetition work, special pipes and burners may be used.

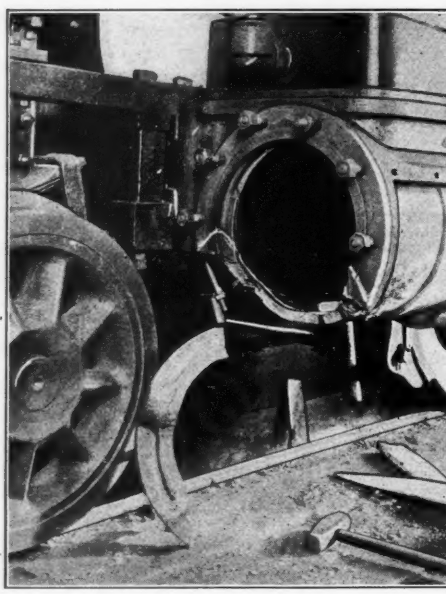


Fig. 1. The Broken Cylinder

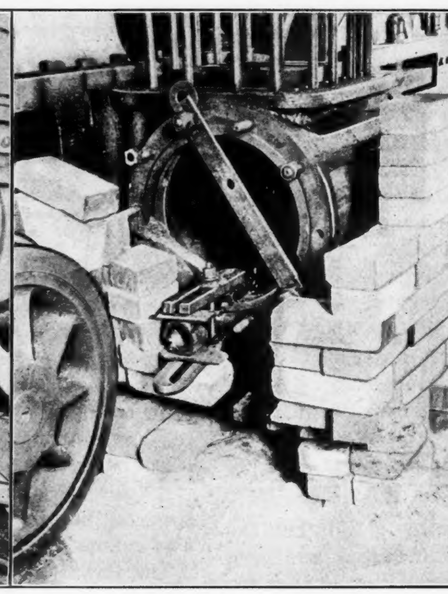


Fig. 2. Arrangement for Pre-heating

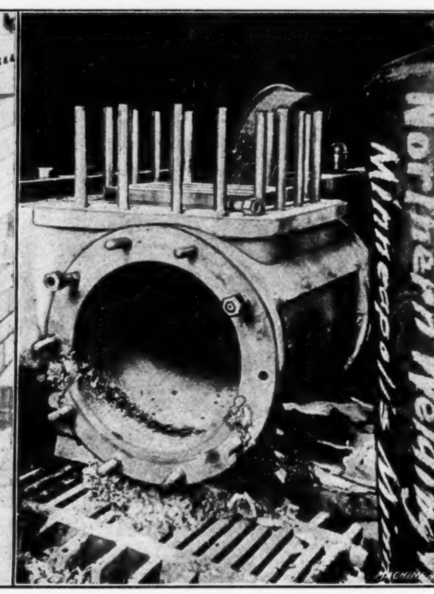


Fig. 3. After Welding, before Cleaning Weld

In one plant in Europe, where tubing is manufactured with the aid of power-driven gas-welding machines, provision is made for the rolled but unwelded tube to pass through a muffle just before reaching the torch, so that the tube is bright red when passing under the torch. Sometimes the outer flame of the torch itself may be used for pre-heating. Thus the Edison Storage Battery Co. employs a machine (see MACHINERY, September, 1911, engineering edition, "Oxy-acetylene Welding and the Edison Storage Battery Can") in welding a straight seam on the containing cans of their batteries. The torch, the work, and the clamping devices are so arranged that the outer flame of the oxy-acetylene jet is divided into two long streamers. One of these impinges upon the seam several inches ahead of the place where it is reached by the working flame. It is possible that this arrangement was not provided with a view to pre-heating, but that is the effect, and a consequent economy in gas consumption is the result.

The use of the outer flame for pre-heating may come to be quite an important factor. A large quantity of heat is generated by this flame. In the machine referred to, the clamps arranged along the sides of the seam are beveled to afford access to the torch, the bevels being quite steep—about 60 degrees. The writer would suggest that similar clamping bars be formed in connection with regular hand-welding work, so as to provide a canyon-like working groove. In hand-welding larger sizes of tubing, it would also be practicable to provide a series of gas jets on a single supply pipe beneath the joint. In this way the edges could be pre-heated with cheap gas.

Pre-heating is often resorted to for reasons other than those of economy of gas consumption. It is used where the effects of expansion and contraction are objectionable. The rise of 2000 degrees in the temperature of a metallic body occasions considerable expansion in every direction. For example, a 12-inch steel bar will lengthen about 5/32 inch. It is easily seen that the sudden swelling and resultant shrinking of only a small part of the work may, at times, have disastrous results. Take as an example the spoke of a fly-wheel with a piece broken out. This piece just fits into its place. If we repair this by making the required grooves and then filling them with new metal, thus producing an apparently good weld, we will find that, upon cooling, a break will frequently occur in the weld or at some other point, due to the contraction. A similar case is met with in a crack in a casting. It is chipped out in order to obtain beveled edges for the flame, the faces are heated, and new molten material filled in. When the weld cools off, however, the new material is likely to shrink away from the walls of the crack.

Now what can be done to meet this condition? If we could uniformly heat the whole work within as well as without, we should probably have an ideal solution, but one of the great objects in oxy-acetylene welding is to localize the heating. We can, however, pre-heat a larger portion of the whole body than is required for the welding alone, and in this way distribute the stresses. In the case of the flywheel, the broken spoke, the adjacent spokes, and the intervening rim may be heated

* For further information on autogenous welding, see "Modern Welding Methods," MACHINERY, December, 1911, and the previously published articles there referred to.

† This article has been prepared with the cooperation of the Davis-Bournonville Co., New York, and is a chapter from a forthcoming book: "Oxy-acetylene Torch Practice."

‡ Address: 608 West 140th St., New York.

to a red heat, gradually diminishing toward the other parts of the wheel, so that the pre-heating itself does not introduce new stresses. When the new material for making the joints is filled in, the spoke is naturally longer than it will be at ordinary temperatures, and while there is a local contraction of the weld, there is also a general contraction of the whole spoke and those adjacent, which diminishes the effect. In the case of a cracked cylinder casting, the pre-heating of the metal beyond each end of the crack, if properly done, will ordinarily open up the crack so that when it is filled with new metal, the amount which is used will be sufficient, when the cylinder

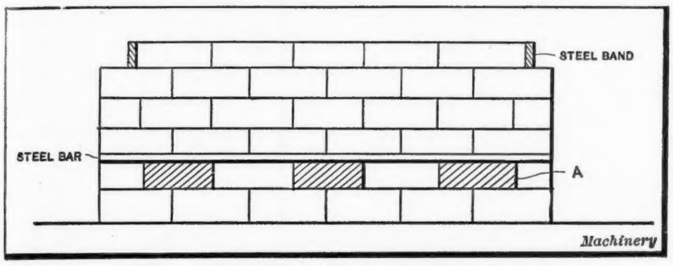


Fig. 4. Arrangement of Temporary Brick Furnace

cools off, to fill the original space. Ordinarily, the walls of the crack should be held apart until the weld is completed, so that the width of the crack and the new metal will contract together. If the crack runs from a point within the periphery all the way to the edge it may be opened up by heating at a point a little further in than the beginning of the crack. The welding is begun at the inner end of the crack, working toward the edge.

The pre-heating should ordinarily be done rather slowly so as not to introduce sudden temperature changes and stresses. Slow heating is especially to be advised when there is a combination of thin and heavy parts. Similar remarks apply to the cooling, which should be slow to be safe; the cooling may be retarded by the use of asbestos sheeting or by packing the object in heated ashes or heated slacked lime.

When it is possible to pre-heat the entire casting, this seems to be the best way of taking care of expansions and contractions. Castings the size of which makes necessary special arrangements may be placed on a bed of fire-brick ar-

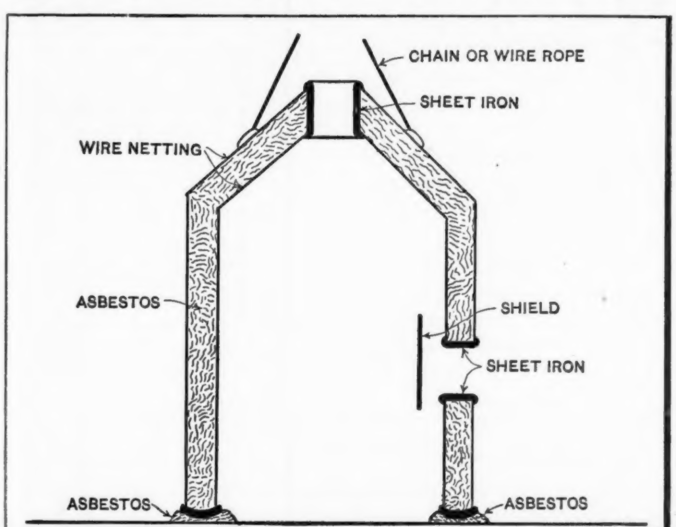


Fig. 5. Hood used for the Pre-heating Operation

ranged with spaces between them. A temporary wall or furnace is then built around the whole, fire-brick being used for this also. These are arranged, of course, without the use of mortar, with very narrow openings between them, one method of constructing such a wall being shown in Fig. 4.

Flat steel bars may be employed just above the separated course of bricks *A*. The top course may be held in place by a steel band. The object of the open spaces is to provide a draft. Charcoal is now filled in between the casting and the wall and the fire started. A sheet of asbestos is used as a cover. This cover should contain a number of holes so as to provide an exit for the gases.

Another method is to make a hood of a material that is a poor conductor of heat. Such a hood is shown in vertical section in Fig. 5. The walls consist of two sheets of wire netting with an intervening space filled with asbestos. A hole, the wall of which is made of sheet iron, is provided at the top. Another aperture also lined with sheet iron is provided on one side of the vertical cylindrical wall. The bottom of the hood is furnished with an annular base ring of sheet iron, the netting and sheet iron being joined by welding. Provision should be made for lifting and lowering the hood, so that it can be let down over the casting which is to be pre-heated. To make a tight joint with the floor, some loose asbestos may be used as a foundation for the hood. A kerosene or other torch may now be inserted through the aperture in the side. Some kind of shield may be used just inside of the side opening to divide the flame, so that, as far as possible, the casting will be encircled by it. Sometimes it is advisable to use auxiliary fires on shelves above the main fire at the bottom. This is especially to be recommended for tall castings, so that there will be no severe concentration of heat at one point. As already mentioned, the heating should be done slowly, the fires being started in a moderate way and gradually increasing in intensity. During the welding the hood must, of course, be raised, and when the welding is completed the hood may again be lowered into position in order to retard the cooling. The oil torch should be brought into service again for a short period. It may then be shut off and the openings of the hood covered. In this way, slow and even cooling is assured.

In general, after a welding operation, the casting should be reheated as soon as the welding is completed, and then covered with asbestos wool or scrap asbestos. The casting may also be buried in any of the materials ordinarily used for retarding the cooling of steel which is to be annealed. If the casting is of such a shape that it is not likely to crack, it may be cooled in the bed of charcoal in which it has been heated.

Cast iron may be pre-heated to about 700 or 1000 degrees F. Generally speaking, the higher the temperature of pre-heating, the less the danger of cracking when cooling. Aluminum castings should be pre-heated to about 600 or 700 degrees F., the heat if possible being maintained during the entire time of welding. To accomplish this, it is often advisable to cover the casting with asbestos and to leave only the working area exposed. Asbestos sheeting will be found satisfactory for keeping any class of work hot during the welding.

It may be of interest to refer to a specific case of welding performed by the Pullman Co. of Chicago. The bed of a hydraulic press was cracked; the casting weighed about 10 tons, and the crack was about 10 inches long and 26 inches deep. The material of the bed was cast steel. The casting was placed on supports of brick about 14 inches high and a fire of wood and charcoal was maintained during the night, with the result that when the welding was begun the metal was at a red heat. A No. 10 Davis-Bournonville tip was used with a soft steel welding rod, two workmen carrying out the work. The time consumed for the welding operation was about five hours. The necessary enlargement of the crack was made by the oxy-acetylene flame. The expense was estimated at $19.16, and the result of the welding was very satisfactory. As the gas cost of the Pullman Co. is extraordinarily low, for ordinary conditions the expense would, perhaps, be as follows:

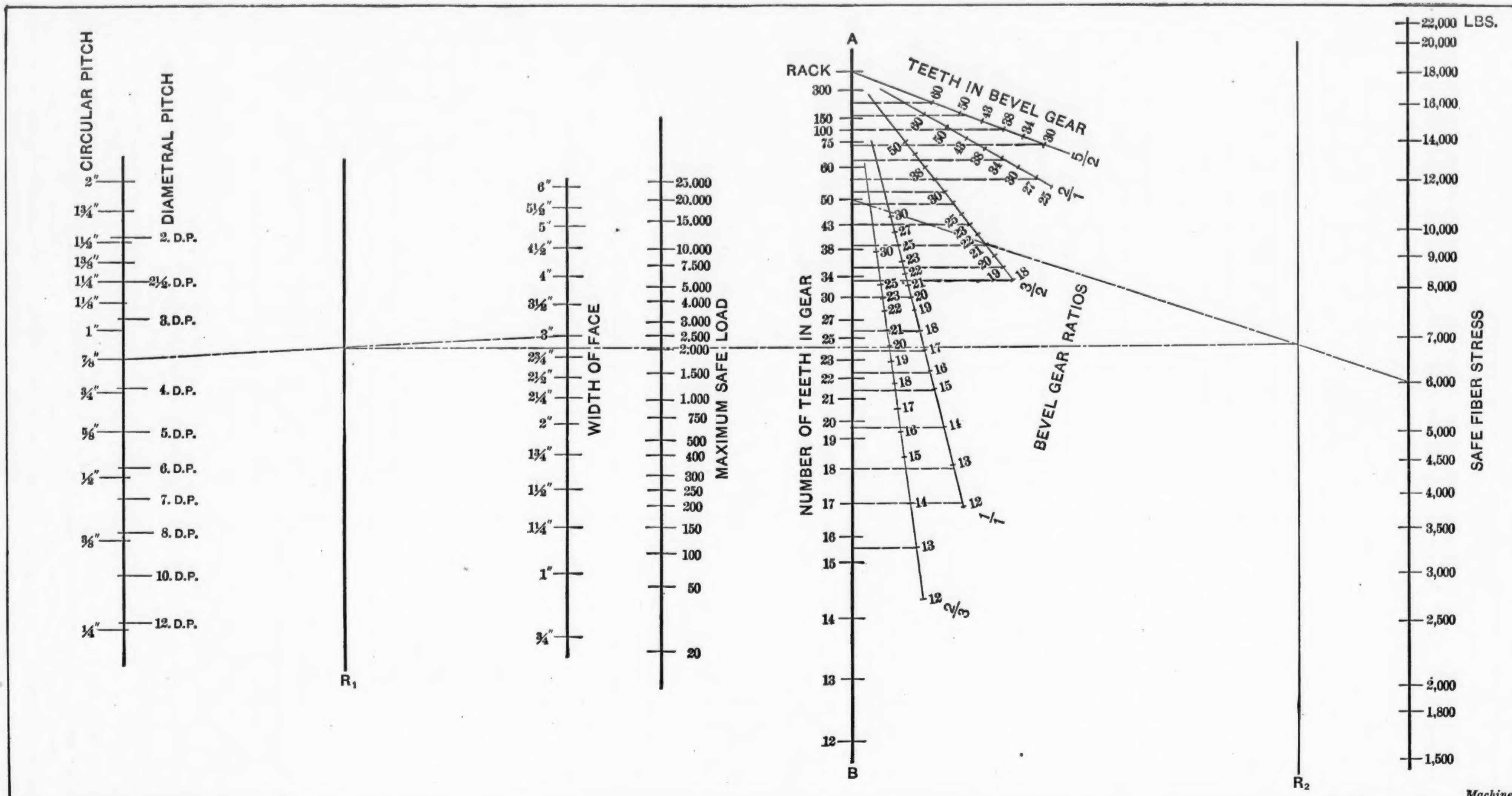
357 cubic feet of oxygen at 3 cents per cubic foot...	$10.71
143 cubic feet of acetylene at 1 cent per cubic foot..	1.43
Labor	7.40
Fuel for pre-heating and annealing................	4.00
	$23.54

The expense of replacing the casting by a new one would have been about $600.

* * *

An investigation of the melting points of tungsten and tantalum has been carried out at the University of Wisconsin, the measurements having been taken with especial care, using the optical pyrometer and a direct vision prism transmitting monochromatic light. The melting point of tungsten was found to be 3002 degrees C. (5435 degrees F.), and of tantalum, 2798 degrees C. (4982 degrees F.). These values are somewhat different from those generally accepted.

CHART FOR FINDING THE STRENGTH OF GEAR TEETH



Conditions of Drive	Pitch Line Velocity, Feet per Minute	Approximate Safe Fiber Stress, Pounds per Square Inch					
		Spur and Bevel Gears				Helical Gears	
		Cast Iron	Steel	Phosphor-bronze	Rawhide	Cast Iron	Steel
Without shock	Any	5000–8000	18,000–20,000	14,000–16,000	2500–3500	5000–8000	18,000–20,000
With shock	200– 800	3000–6000	14,000–18,000	9000–12,000	2500–3500	5000–8000	18,000–20,000
	800–1600	2000–4500	10,000–14,000	6000–10,000	2500–3500	3000–6000	14,000–18,000
	1600–2400	1500–3000	7000–12,000	4000– 7000	2500–3500	2000–4500	10,000–16,000

HOW TO USE THE CHART

Required to find the safe load for a cast-iron gear having 50 teeth, ⅞ inch circular pitch, and 3-inch face; assume the fiber stress to be 6000 pounds per square inch. Join the graduation for ⅞ inch circular pitch with that for 3 inches width of face; also join the graduation for 50 teeth with that for 6000 pounds fiber stress. Then join the points where these two lines intersect lines R_1 and R_2, respectively. The intersection of this joining line with the maximum safe load scale gives the safe load, which for this gear is about 2050 pounds.

LOGARITHMIC CHART FOR FINDING THE STRENGTH OF GEAR TEETH*

BY H. T. MILLAR†

The accompanying illustration shows a logarithmic chart for the strength of cut gearing. The chart is based on the well-known Lewis formula. The method of using it is explained by the example shown in dash-dotted lines. Assume that it is required to find the safe load for a cast-iron gear having 50 teeth, the gear being of 7/8 inch circular pitch and having a 3-inch face. The fiber stress is assumed at 6000 pounds per square inch. To use the chart, join the graduation for 7/8 inch circular pitch with that for 3-inch width of face; also join the graduation for 50 teeth with that for 6000 pounds fiber stress. Join the points where these two lines intersect lines R_1 and R_2, respectively. The intersection of this joining line with the scale for the maximum safe load indicates that the safe load for this gear is about 2050 pounds.

The tooth form of a bevel gear is stronger than that of a spur gear of an equal number of teeth. The chart can also be used for bevel gears, as indicated. The increase in strength due to various cone angles is taken care of by the diverging lines marked with the ratio of the bevel gears. To use the diagram for bevel gears, follow the horizontal line from the actual number of teeth in the bevel gear to the scale *AB;* then use the number of teeth thus found on this scale for determining the strength, as already explained in the previous example. In using the chart for bevel gears the pitch selected must be the mean or average pitch and not the nominal pitch.

Some notes on helical gearing may be of interest, and may be found useful on account of the increased use of this class of gearing. The increased strength of helical gearing comes from two causes. The meshing action is more continuous, and, therefore, a high velocity is not so likely to induce shock. The contact between two helical teeth in mesh is very different. The line of contact is inclined across the face, beginning at the root and passing through the pitch line to the point. Considering, therefore, the tooth as a cantilever, the mean leverage of the load is less than with a straight cut tooth, where the load may have a leverage almost as great as the tooth depth. The angle of the tooth helix is usually so arranged that with a minimum width there is always contact at the pitch line of one of the teeth in mesh. In practice, it has been found that most double helical gears, especially pinions, fail through wear rather than through breakage, since in the usual case of helical gear reductions the circumferential speed of the gears is high. It is not wise to have a bearing pressure per inch of width very much higher than that given in the Lewis formula, unless the teeth are lubricated. It is also customary to select a fine pitch and a relatively wide face, say about six times the circular pitch, or 20 divided by the diametral pitch. When using the chart for helical gearing, the maximum safe load may be obtained by selecting a somewhat larger pitch than the actual one, and this pitch should be used for the graphical work.

* * *

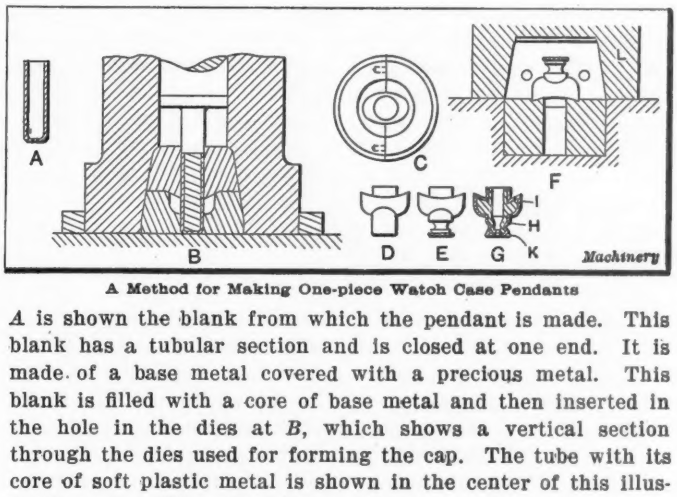
METHOD OF MAKING WATCH CASE PENDANTS

In the August, 1912, number of MACHINERY an article appeared entitled "Watch Case Manufacture," in which the making of a number of parts of watch cases is described. Little attention is given in this article, however, to the making of watch case pendants. It may, therefore, be of interest to show, in general outline, a method for making one-piece pendants as invented by Charles W. Butts of Sag Harbor, N. Y., and described in U. S. Patent No. 865,759, from which the accompanying description has been obtained. The principal object of this invention is to form a watch case pendant wholly of one piece from what is commonly known as "filled" metal or "gold-filled"; that is, gold covering a base metal, which latter must not be exposed after the pendant is formed.

The principle employed for accomplishing this result is to use dies of such a shape that when a straight tubular blank containing a core of a soft plastic metal is placed within the dies and pressure is brought to bear upon the blank and the core, the metal of the blank and core will flow into the cavities of the die and thus form a pendant of the desired shape. The pendant is then removed from the die, which is made in halves for this purpose, a central hole is drilled in it, and by means of rolls the lower part of the body of the pendant is depressed and a foot and bead are formed on it. The final over form of the foot of the pendant is obtained by placing the pendant, after the foot and bead have been formed, within a die made in halves and exerting pressure upon it. In this way it is possible to produce a pendant in one piece.

In the past, watch case pendants have generally been made in two pieces, the body and foot of the pendant having formed one piece, while the oval cap has been made in a separate part, these parts afterward being soldered together. Pendants made in this manner are not satisfactory, for the reason that, in forming the cap separate from the body of the pendant, the filling metal is necessarily exposed in some places; nor is an absolute uniformity in product possible when the pendants are made in two parts and afterward fastened together.

The accompanying illustration shows, in a general way, the methods for making the pendants in the manner described. At



A Method for Making One-piece Watch Case Pendants

A is shown the blank from which the pendant is made. This blank has a tubular section and is closed at one end. It is made of a base metal covered with a precious metal. This blank is filled with a core of base metal and then inserted in the hole in the dies at *B*, which shows a vertical section through the dies used for forming the cap. The tube with its core of soft plastic metal is shown in the center of this illustration. By filling the blank with a core of base metal, the tubular blank is caused to flow more quickly and evenly into the cavities of the die, and, at the same time, the strain on the precious metal covering is relieved while the cap on the pendant is being formed. When the plunger descends upon the blank the core of metal of the latter is upset and forced to flow outward, thus preventing the wall of the blank from collapsing inward. When the plunger has reached the limit of its downward stroke, the walls of the metal blank will have been forced tight against the walls of the cavity in the die. A plan view of the lower die is shown at *C*. The die is made in two parts in order to make possible the removal of the formed pendant after the operation is completed.

At *D* is shown the appearance of the pendant after the blanks have been operated upon by the dies shown at *B*. The core, after this operation, of course, completely fills the blank, and a hole is then drilled through it, this hole being shown in the section at *G*. The blank is then placed between rollers or other suitable tools and the cylindrical part is spun and the foot and bead formed so as to give it the shape indicated at *E*. After the foot and bead have been formed on the lower portion of the body, the blank is inverted and placed so that the oval cap will rest within the depressions of the dies shown in section at *F*. The upper die is made in halves which, when placed together, give the foot and bead their final oval shape. This is accomplished by having the two halves of the die slightly apart at the beginning of the operation, but forcing them together by the block *L* as the operation proceeds, the outside of the die and the inside of blank *L* being conical in shape as indicated. A section of the pendant after this operation is completed is shown at *G*. The part *H* is cylindrical, while the cap *I* and foot *K* are oval in shape. The hole through the pendant is made, of course, in any suitable manner to fit the winding-stem of the watch.

* See MACHINERY, January, 1908, engineering edition: "Variation of the Strength of Gear Teeth with the Velocity." See also MACHINERY's Reference Book No. 15, "Spur Gearing," Chapter VI.

† Address: 150 Waterloo Road, Manchester, England.

It will be seen that the process briefly consists in the making of a one-piece watch pendant by first upsetting a cylindrical blank to form a non-cylindrical cap and a cylindrical base, using a core of soft plastic metal within the tubular blank to accomplish this, and then drilling the hole through the soft metal core. The base is then spun to form a cylindrical foot and bead, and finally the foot and bead are compressed into a non-cylindrical shape.

* * *

ALLOWANCES ON PARTS TO BE ASSEMBLED BY PRESSURE*

BY S. M. HOWELL†

The following article gives some data on the allowances for parts to be assembled by pressure. The subject is one of much importance in machine construction, and the data given has been secured by observation and personal experience in a large number of cases.

In making a press fit, the pressure at which the parts are assembled is estimated from the size and character of the job and the degree of tightness desired. In the case of very large work, the pressure may be limited by the capacity of the press. When the tonnage of pressure has been decided, the next step is to determine the allowance on the parts for the fit, that is, how much larger the fitted part should be than the hole into which it is forced, in order to enter at the required pressure. In plants where a special line of machinery is regularly manufactured, and the same parts are continually made, work to be assembled in this way is machined to dimensions which are known to be right from previous experience, and is usually fitted to gages; but in repair shops and other places where the work is of a more diversified character, the allowance must be determined in each individual case.

The "feel" of the calipers is, of course, a ready way of judging small variations of size, and is sufficiently reliable for many purposes, but when more definite results are desirable, a predetermined allowance, accurately measured, should be made. For this purpose an inside micrometer gage and a pair of outside calipers constitute a practical device.

In determining the allowance to be made in a given case, the governing conditions are the diameter and the length of the bearing, and to a greater or less degree also the character of the material and the smoothness of the surfaces of the fit. It is obviously impossible to accurately calculate the effect of varying degrees of hardness and other irregular conditions by means of mathematical formulas. In the majority of cases, however, the shaft or pin to be forced into place is of soft steel, and the receiving part is either of cast iron, or is a steel casting. The material is of average quality and the machined surfaces are slightly rough, the finishing cut having been taken with a moderate feed and without filing. Assuming these to be the conditions, the allowance to be made for the fit will, in a general way, depend upon the diameter and length of the bearing and the required tonnage. For finding the allowance, the following rule is applied:

Multiply the pressure in tons by 4.4, and divide the product by the product of the length and diameter in inches. The quotient is the allowance in thousandths of an inch. This rule may be given as a formula, as follows:

$$A = \frac{4.4P}{LD}$$

In this formula

A = allowance in thousandths of an inch,

D = diameter of hole in inches,

L = length of fit in inches,

P = pressure in tons.

As an example, assume that a pin is to be forced into a hole 4 inches in diameter, 6 inches long, the pressure being 40 tons. From our formula we find:

$$A = \frac{4.4 \times 40}{4 \times 6} = 7.3$$

Hence the proper allowance is 0.0073 inch.

As another example, assume that a shaft is to be forced into a hole 5 inches in diameter with a pressure of 60 tons; the length of the bearing is 8 inches. Then:

$$A = \frac{4.4 \times 60}{5 \times 8} = 6.6$$

Hence the allowance is 0.0066 inch.

The rule can be transposed so that we can find the required pressure when the allowance and the length of the bearing are known. In this case the rule will be:

Multiply the length by the diameter in inches, and multiply this product by the allowance in thousandths of an inch; divide this final product by 4.4.

The quotient will be the required pressure in tons. As a formula this rule becomes:

$$P = \frac{LDA}{4.4}$$

As an example, assume that a pin 2 inches in diameter is to be forced into a bearing 4 inches long, the allowance being 0.004 inch. What will be the required pressure in tons?

$$P = \frac{4 \times 2 \times 4}{4.4} = 7.3 \text{ tons.}$$

When forcing shafts into large rollers there is usually a short bearing at each end. In this case the shaft must be driven into both bearings at once, and the pressure required will be double that of a single bearing of the same length, or, in other words, in calculating the allowance, the length used in the formula must be equal to the sum of the length of the two bearings.

In small work where the parts are strong and it is required that they be tightly driven, an allowance of 0.002 inch per inch of diameter may be made, but care must be taken that the required pressure is not so great as to strain the material beyond its elastic limit; otherwise there is danger of damage to the work even if there is no visible distortion at the time of making the fit. In work of moderate size, an allowance of 0.001 inch per inch of diameter is usually made, but this is excessive for large diameters. In making a shrink fit, where the maximum tightness is required, a shrinkage allowance of 0.003 inch per inch of diameter may be used, provided the parts are strong enough to stand it.

A driving fit may be based upon an estimate of 10 tons pressure at the most, but the allowance should never exceed 0.001 inch per inch of diameter, and frequently must be much less. As a matter of fact, the allowance for light driving fits is often so small that it is best estimated by the "feel" of the calipers alone. If a hole is not true, but oblong, or tapers slightly, it should be calipered near the small end. In these cases, the parts will go together at a somewhat lower tonnage than if the hole were true.

The outside calipers used in this and other work requiring accuracy should have parallel chisel points about 1/16 inch wide, slightly rounded or dulled on the extreme edges. These points should be casehardened and smoothly finished. The inside pair may have one chisel point and the other point rounded or spherical. With calipers of this kind, a size may be transferred from one caliper to the other more easily and with greater certainty than if all the points were round or of an irregular shape which they might have acquired from use.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Shrinkage and Press Fits in the Bradford Shops", August, 1911, engineering edition; "Shrinkage and Forced Fits", April and May, 1911, engineering edition; "Machine Shop Practice—Shrinkage and Forced Fits", July, 1909. See also MACHINERY'S Data Sheet Book No. 7, "Shafting, Keys and Keyways", pages 28, 29 and 31.

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* * *

One of the Middle Western railroads—the Illinois Central—has appointed an official whose duties are practically that of a "courtesy expert." The official title is: "Inspector of Passenger Train and Station Service." His duties will be to see that passengers are enabled to make use of every convenience which the system affords, to suggest improvements for the comfort of the passengers, and to travel on passenger trains so as to ascertain in person the conditions of the service as far as it pertains to the comfort and convenience of the passengers.

THE MANUFACTURE OF BLUEPRINT PAPER

CHARACTERISTICS OF PAPER, SENSITIZING AND SENSITIZING SOLUTIONS

BY F. B. HAYS*

The constantly increasing use of blueprints has caused the manufacture of blueprint paper to become an industry of considerable magnitude. The majority of people connected with engineering work have a fairly clear idea of the methods employed in making blueprints, and a few draftsmen and engineers understand the principles of coating the paper, but only a very small number have any conception of the methods and processes employed in producing large quantities of blueprint paper. The following article briefly describes the most general methods used. The machinery illustrated in the accompanying halftones is installed in the plant

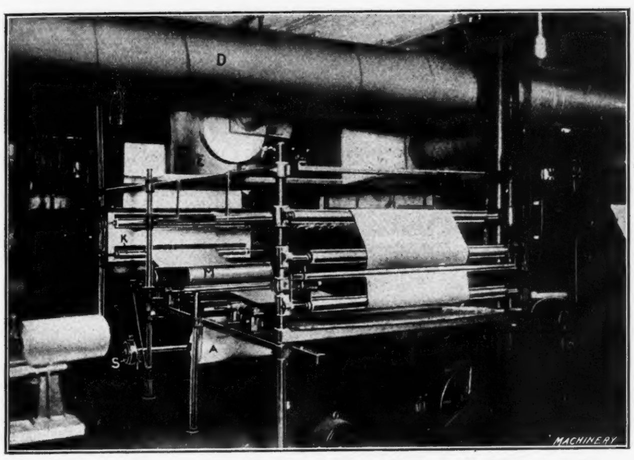

Fig. 1. Front View of Coating Machine and Dryer for Blueprint Paper

of the Indianapolis Blueprint and Supply Co., and is said to be the most modern and efficient type in use.

A special kind of paper is used in making blueprint paper. The principal requisites of this paper are: first, that it be free from wood pulp and the chemical impurities that are found in cheap papers such as newspaper stock, wrapping paper, etc.; second, that it be sufficiently tough to withstand frequent washing and rough handling; third, that it possess a fairly hard, and not too absorbent or coarse grained surface; and fourth, that it be properly sized on that surface which is to receive the coating. The size which gives the best results

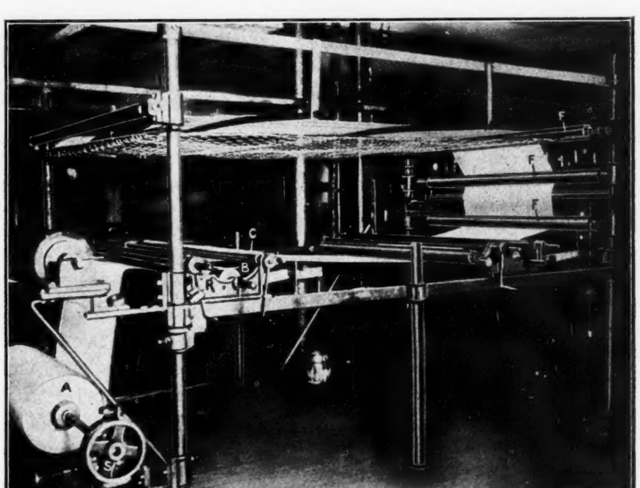

Fig. 2. Side View of Machine shown in Fig. 1

is a mixture of arrowroot flour and water. The flour is first mixed with a sufficient quantity of cold water to produce a thick paste, and then from forty to fifty parts of warm water is added.

Sensitizing Solutions

The process of coating paper for blueprinting is termed "sensitizing," and it consists of coating the paper on one side with a solution that undergoes marked chemical changes when brought into contact with certain kinds of light and water. This process, although more or less complicated from a chemical standpoint, is very simple mechanically, provided only small quantities of paper are to be sensitized, but when done on a large scale special machinery and very skillful handling are required.

One of the oldest and most popular formulas for sensitizing paper that will print white lines on a blue background is: (A) Ammonia-citrate of iron, 20 parts; water, 100 parts. (B) Potassium ferricyanide, 16 parts; water, 100 parts. The sensitizing solution is made by mixing equal parts of (A) and (B) together, and filtering just before using. Another solution which gives good results, and which may be kept on hand for several months without deteriorating, is the following: (A) Ammonia-citrate of iron, 12 parts; water, 16 parts. (B) Potassium ferricyanide, 9 parts; water, 16 ounces. Mix together and filter one part each of (A) and (B), and add two parts of water just before using.

For coarse-grained, rough-surfaced papers, and silk and linen cloth, an excellent solution is obtained by the use of gum arabic. (A) Pulverized gum arabic, 1 part, dissolved in 20 parts water, and strained through muslin, combined with ammonia-citrate of iron, 5 parts. (B) Potassium ferricyanide, 4 parts, water, 20 parts. Equal parts of (A) and (B) are mixed before using. Fabrics must be washed and then sized in gelatine (hard gelatine dissolved in twenty parts water) before sensitizing.

Positive paper, or that which gives a blue line on a white background is produced in the same manner as negative

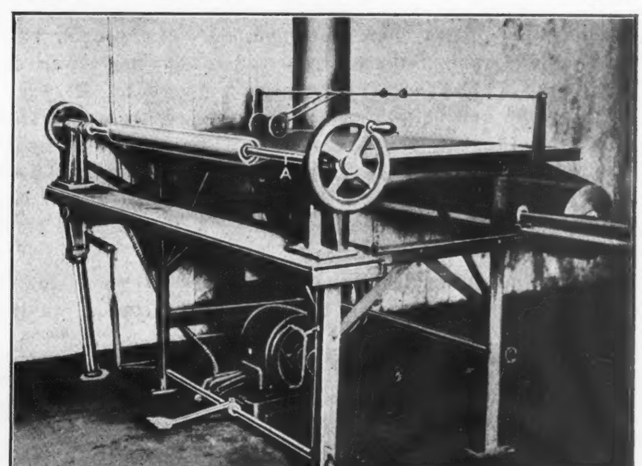

Fig. 3. Measuring Machine for Blueprint Paper

paper, except that it is sensitized with different solutions. A number of mixtures may be used, but the two following are probably the most popular:

1. Oxalic acid, 1 part; iron perchloride, 2 parts; water, 20 parts.
2. (A) Powdered gum arabic, 2 parts; water, 10 parts. (B) Ammonia-citrate of iron, 2 parts; water 4 parts. (C) Chloride of iron, 1 part; water, 2 parts. First dissolve the gum and strain the solution (A) through muslin; add solution (B) to solution (A), stirring well; finally add solution (C) to the mixture of (A) and (B). This solution must be kept for twenty-four hours in the dark and must be frequently agitated before using.

Paper which produces positive black lines on a white background is sensitized and then developed. The sensitizing is a solution consisting of ferrous sulphate, 20 parts; ferric chloride, 45 parts; tartaric acid, 40 parts; water, 190 parts. The developing solution is a mixture of gallic acid, 15 parts; oxalic acid, 2 parts; water, 1700 parts. After developing, the prints are washed in running water.

In mixing any of the foregoing solutions, only distilled water should be used, and all operations should be carried out in a red or orange light.

Sensitizing the Paper

The coating of the paper with the sensitizing solutions and the subsequent drying and rolling is now done entirely by

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machinery. Fig. 1 shows a general view of a machine for this purpose. The coating machine is shown towards the front and the drier in the background. The driving mechanism is shown on the floor in front of the machine. The air for the drier is received from a purifier and forced through pipe *D* and heater *E* into the drying oven. The general operation of the machine is as follows: The sized paper starts from the roll *A*, Figs. 1 and 2, and passes between two pulling rollers and over the celluloid coating roller *B*, Fig. 2. This roller is partially submerged in the coating solution placed in tank *R*, and as it revolves it carries a small film of the solution, which is absorbed by the lower surface of the paper. A glass bar runs along the edge of the tank, and a roller *C* presses the paper against this bar so that all excess solution is wiped from its surface and returns to the tank. This latter roller also regulates the pressure between the paper and the coating roller *B*. The bearings for roller *C* are placed in a rocker arm, so that it may be raised or lowered by means of a crank, thus decreasing or increasing the tension on the paper. Another retaining tank and a similar series of rollers is shown at the other end of the machine, and serve to administer the second coat of the solution. The rollers *F* are simply guide rollers, and the tubes above the machine prevent the paper from sagging and becoming strained between the guide rollers. All of the rollers are made of brass, except the coating roller which is made of celluloid, and are mounted upon ball bearings. They are driven from the main shaft by gears proportioned to impart the same lineal speed to each roll.

At *S*, Fig. 2, is shown a band brake which regulates the tension of the paper and also prevents it from unrolling from the spools when the machine is stopped. Upon leaving the coating machine the paper immediately enters the drier, where it runs upon rollers along the upper part of the drier to the extreme end, and returns upon rollers on the lower side, leaving at *K* and being wound upon the spool *M*, Fig. 1. Both the top and bottom of the drier are covered with steam coils, and the hot air forced into it thoroughly dries the sensitized paper before it is wound upon the spool *M*. The moist air is removed from the drier by a pipe at the back, which terminates at an exhaust fan on the outside of the building.

As it is necessary to keep the colored windows of this department closed because of the injurious effects of daylight

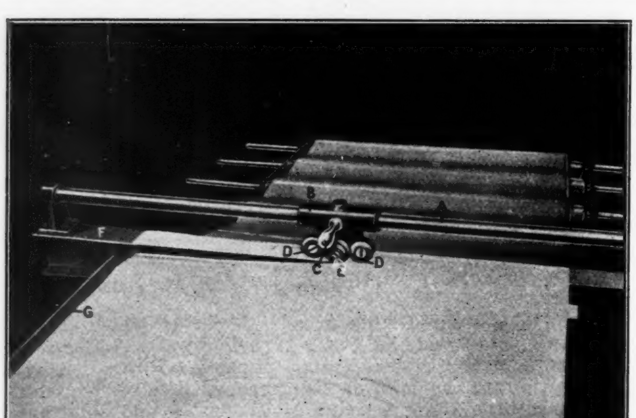


Fig. 4. A "Cutting-off" Machine

upon the finished paper and the sensitizing solutions, air is artificially supplied by blowers and exhaust fans.

When the rolls of sensitized paper are removed from the coating and drying machines (each of which has a capacity of 1500 yards an hour), they are taken to the rerolling and measuring machine shown in Fig. 3, where they are rerolled into packages of desired length for the market. This machine consists of a "rolling" shaft *A* having a universal joint and driven through a friction clutch at the left from the motor beneath the machine; the clutch is controlled by a foot pedal. The operation of the machine is as follows: The operator places one of the large rolls of paper from the drier on the shaft at the back of the machine and starts it upon the "rolling" shaft *A* by means of the handwheel. This wheel has a jaw clutch connection with the shaft, so that it can be slipped out of connection with the shaft as soon as the paper is started, and the shaft driven by power through the clutch. As the paper passes over the table of the machine the registering device shown records the number of yards rerolled, so that the operator simply has to throw out the clutch and cut off the paper when the package has reached the proper size. The shaft *A* is then swung out on its universal joint and the roll slid off and sent to the packing department, where it is wrapped in light-proof paper and sealed up ready for the market.

Frequently orders for large quantities of short lengths of paper are received, and are handled by means of the mechanism shown in Fig. 4. This consists of four shafts, each

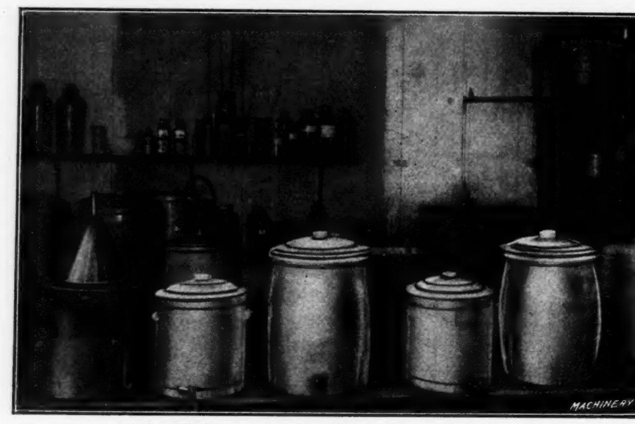


Fig. 5. Section of Department for Sensitizing Solutions. Note that all Solutions are kept in Light-proof Receptacles

inserted into a roll of paper, and supported by a steel plate on each end; a polished steel guide *A*; a steel I-beam support *F*, which is finished on the top and upper edges; two ball bearings *D*; a hardened tool steel cutter *E*; a handle *C*; and a body casting *B*. The paper is pulled from the rolls in four layers (one from each roll) and measured by means of a steel scale *G* on the edge of the table. The operator then pushes the cutter across the paper by means of the handle *C*, the ball bearings holding the paper rigidly in place while the cutter shears it off. The top of the beam *F* acts as a cutting table, and the finished edge serves as a sharpener for the circular cutter. Five hundred and eighty yard lengths of paper an hour are cut by this device. It is especially successful in handling tracing cloth and drawing paper.

The principles involved in the chemistry of sensitizing paper for blueprinting were first discovered about 1725, but were not practically applied until 1835 when an English scientist, Sir John Herschel, developed the ferro-prussiate process, which is still used at the present day and which serves as a basis for all other blueprinting methods. Many new branches of industry have arisen since 1835, and practically all the methods of the old industries have been greatly changed and improved, but the principal chemical processes of making blueprints are virtually the same now as they were twenty-seven years ago. Great strides have been made in the mechanical methods of making, coating, and printing blueprint paper, but no improved simple and efficient chemical process has been developed for producing sensitizing solutions, or for incorporating them with the fabrics. What we need at the present time is a cheap, reliable, quick printing paper that will require neither developing nor washing after printing, and that will withstand rough usage and not fade a short time after printing. It seems reasonable to believe that such a paper could be produced at the paper mills by incorporating the sensitizer with the primer, provided a suitable sensitizing solution were discovered. Far more wonderful developments than this have been made in the chemistry of photography, but for some reason chemists seem to have entirely overlooked its sister subject, blueprinting. Let us hope that in the near future chemists will turn their attention to this matter, and that the chemical side of blueprinting will be greatly simplified and improved.

WIRE ROPES FOR LIFTING APPLIANCES*†

AN INVESTIGATION INTO SOME OF THE MOST IMPORTANT CONDITIONS THAT AFFECT THEIR DURABILITY

The question of the durability of the parts of mechanical structures seems to be strangely neglected by all authorities. A designer has generally the choice of several formulas for calculating the mere strength of a given member, but usually he has to depend upon his own experience for the correctness of the proportions that will insure for it a reasonable length of life. The durability of wire ropes, in particular, is of great importance to all engineers, whether engaged in the design and manufacture of lifting appliances, or in their care and management.

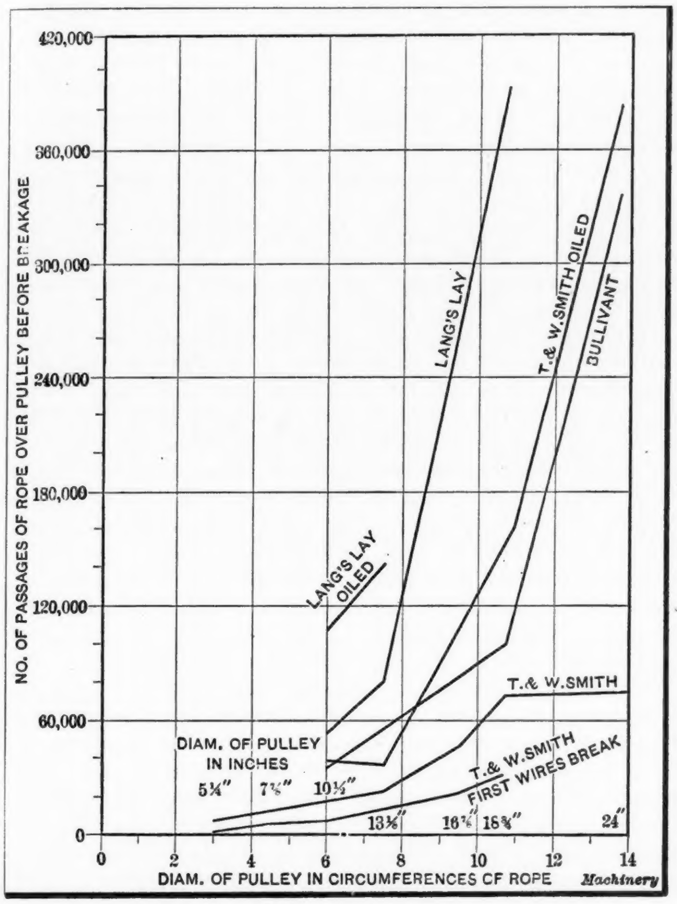


Fig. 1. Results of Experiments on the Durability of Wire Ropes

The two most important conditions appertaining to the manufacture and use of steel wire ropes that affect their durability are the quality of the material and the size of wire, and the diameter of the pulleys and arrangement of the ropes.

Quality of Material and Size of Wire

The wire used for lifting ropes is of crucible steel having a tensile strength varying from 80 to 130 tons per square inch. Although ropes made from material having a high tensile strength are of smaller diameter for a given load and a given factor of safety, this is not of great advantage to the crane designer. The stiffer character of the wire makes larger drums desirable, if the durability of the rope is to be considered, notwithstanding the fact that some rope-makers claim as an advantage for the stronger material that it does enable smaller pulleys to be used with a consequently lower cost of the working parts of the crane.

The ratio of the diameter of the individual wires to the diameter of the completed rope is an important factor. If the wires are too large, they are stressed considerably when passing over the pulleys, and accordingly the material is quickly fatigued and the wires break. Smaller wires, on the other hand, are more quickly worn through by rubbing against the pulleys and against their neighbors in the body of the rope. The stress in a wire due to bending round a pulley is directly proportional to the modulus of elasticity and to the diameter of the wire, and inversely proportional to the radius of the pulley; therefore, the radius of the pulley should be increased with an increase in the modulus of elasticity, if the same number of bends is to be endured by a stronger wire of the same diameter. Unfortunately, a theoretical calculation of the stresses induced in the wires of a rope by being bent over a pulley does not alone afford a reliable guide to the length of life to be expected from the rope, for consideration must also be given to the mutual wear that takes place among the wires.

Assuming, for the purpose of comparison, that two ropes are constructed of equal size, one from wires half the diameter of those in the other, then, for equal strength, the one rope will have four times the number of wires, and each of the wires will have one-quarter the cross-sectional area. According to the usual formula, the stress due to bending will be half as severe in the smaller as in the larger wires, when the ropes are bent over pulleys of the same diameter. If it be allowed that a reasonable figure for the estimated stress due to bending an ordinary rope over a pulley of a size usually adopted in crane design be, say, 30 tons per square inch, and that the stress due to the suspended load be 10 tons per square inch, then there will be a stress of 40 tons per square inch in the material each time the maximum load is lifted and released. The corresponding stresses in the rope of finer wires will be 15 tons per square inch due to bending, and, as before, 10 tons per square inch due to the suspended load, or a total of 25 tons per square inch.

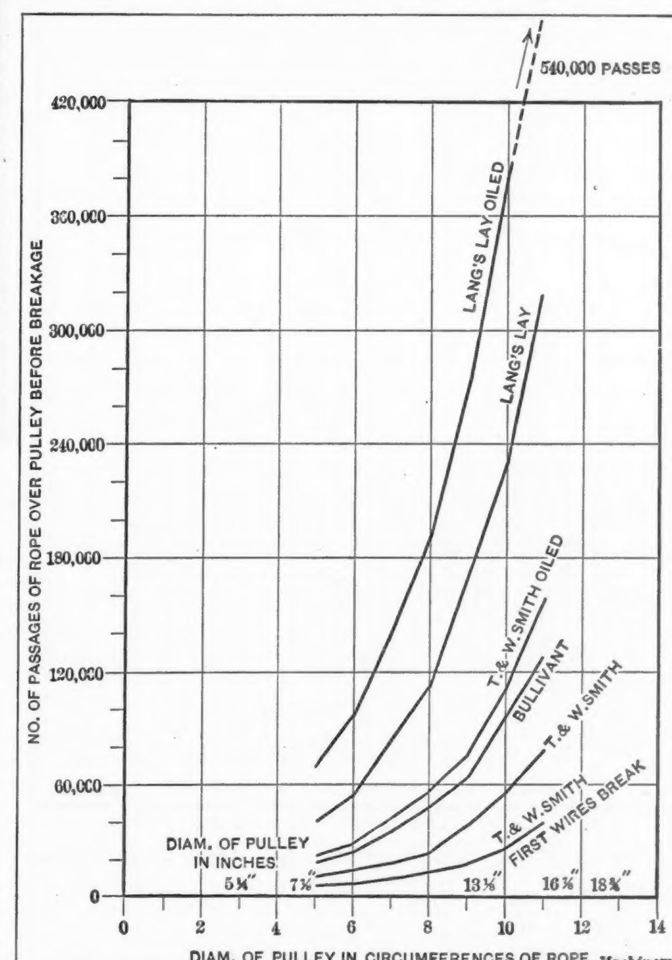


Fig. 2. Curves based on the Data in Fig. 1, covering the Conditions of General Overhead Crane Practice

There is, as yet, no agreement as to the exact effect upon endurance, of variations in the working stresses. It seems, however, to be reasonable to assume that a reduction in range of stress from 40 tons per square inch to 25 tons per square inch would increase the life of material such as ropes are

* Abstract of a paper by Mr. Daniel Adamson, read before the Belfast meeting of the Institution of Mechanical Engineers, Great Britain, July, 1912.

† See also the following articles previously published in MACHINERY: "Stresses in Wire Rope due to Bending," February, 1909, engineering edition; "Bending Stresses in Wire Rope," June, 1907, engineering edition. See also MACHINERY'S Reference Book No. 24, Chapter III, "Bending Stresses in Wire Rope."

composed of about 500 times. As no such improvement in the life of a rope has ever been experienced, or is to be reasonably expected, it must be taken for granted that abrasion is the principal factor in limiting the life of wire ropes, and, therefore, the effect of abrasion upon the suggested rope of finer wires must be considered.

When the rope of finer wires is passing over the pulley, there being four times as many wires in it, the pressure at each point of contact between the rope and the pulley and between the individual wires of the rope may be assumed to be one-quarter of what it is in the rope of larger wires. The wires being of half the diameter, the damage done to them by contact, even under this lower pressure, will be at least half that done to the coarser wires in the other rope, and this half damage done to a wire of one-quarter the sectional area will result in the cutting through of the wire in half the time, so

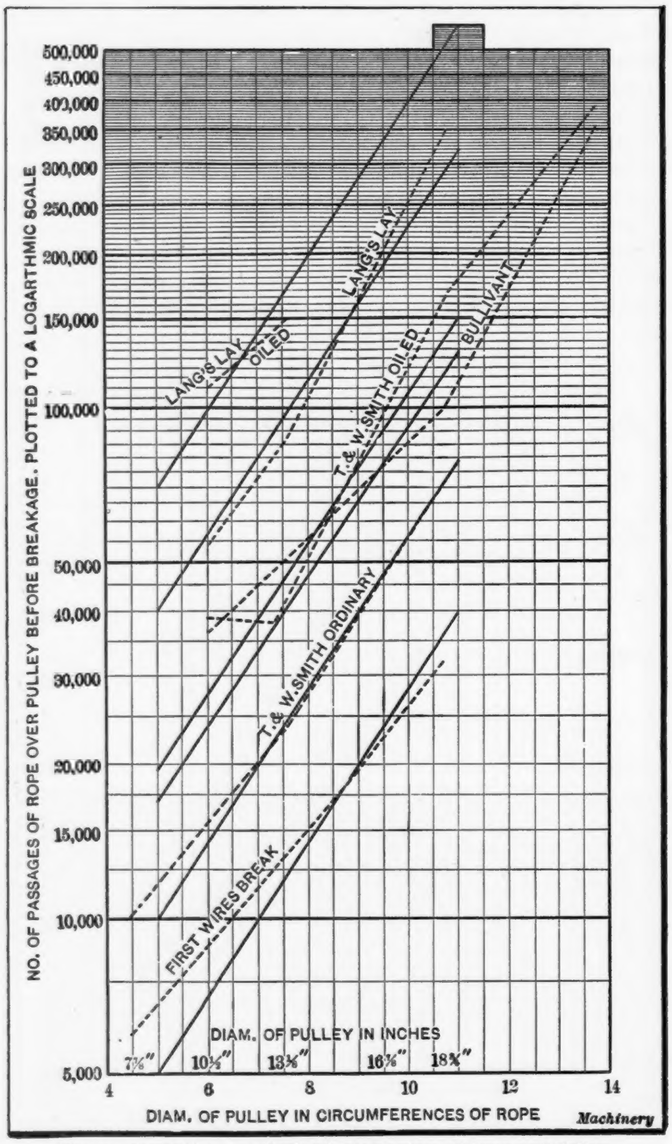


Fig. 3. Durability as affected by Diameters of Rope and Pulley

that the effect of abrasion upon the rope of finer wires will be twice as great. If a smaller pulley be used for the rope of finer wires, as suggested by some authorities, the pressure at the points of contact and the stress due to bending will be proportionately increased, so that it may reasonably be expected that with a pulley-diameter bearing in each case the same proportion to the diameter of the wires, the life of the rope with fine wires will be one-quarter of that of the rope of coarser wires working over a pulley of correspondingly increased diameter.

A German investigator (Ernst Heckel) refers to the very great surface pressures on the wires at the place of contact with the pulley (amounting in his opinion to as much as twelve tons per square inch) as a vital point in connection with the wear of wire ropes. This high pressure, accompanied as it must be by relative movement, even if quite small, readily accounts for the wear which takes place on the surface of the wires where they touch the pulleys or the other wires in the rope.

Diameter of Pulleys and Arrangement of Ropes

The lists issued by makers of wire ropes contain recommendations as to minimum sizes to be adopted, but no information is given as to the effect of using pulleys of different diameters. The author has felt for many years past the want of such information, but the experience of users afforded no reliable guidance, on account of the great difference in the conditions under which ropes work in different shops. In a paper read before the Manchester Association of Engineers by Mr. Matthews in 1902, he states that from 400 to 1700 lifts per crane per annum was the amount of duty required from certain cranes under his control, while the present author, in the discussion on Mr. Matthews' paper, mentioned from 32,400 to 43,200 lifts per crane per annum as representing his own experience in another class of work. Other important features that will affect the life of a crane rope are the average weight lifted and the average height of lift; cranes are generally occupied with loads much below their nominal capacity, but this will vary in different workshops, as will the proportion between the maximum height of lift available and the height most frequently attained by the hook.

Inquiries addressed to the users of cranes elicited varied replies; ropes working upon cranes of the same general design were found to last for periods of from two years to ten years and upwards, and one correspondent suggested that twenty years might be expected from ropes on cranes (of from five to twenty tons capacity) if damage from accidental causes could be eliminated. As might be expected, the ropes on foundry cranes have not so long a life as in erecting shops, the relative difference being perhaps as three is to five.

The most reliable and consistent information that the author has been able to discover is contained in a paper by Mr. A. S. Biggart, published in 1890 in the *Proceedings* of the Institute of Civil Engineers, Vol. CI, page 231. The experiments to which this paper refers were undertaken with the object of selecting the best form of rope to be employed in the construction of the Forth Bridge. The apparatus used by Mr. Biggart contained two pulleys, round which the rope under trial was passed, the lower pulley being weighted to give the required tension on the rope. The experiments consisted in passing the ropes, under a normal working load, to and fro over the pulleys until breakage ensued. Experiments were repeated with different diameters of pulleys and different makes of rope. and the accompanying diagram, Fig. 1, shows the life of different classes of rope as affected by the diameter of the pulleys.

The effect of oiling the ropes is shown by the diagram to be very beneficial, increasing the life of a given rope by two or three times. This is obviously due to the reduction of the cutting action of the wires upon each other. Experiments were also made to ascertain the effect on the life of a rope of running it over pulleys so arranged that the rope was subjected to reverse stresses, as shown in Fig. 4. The results obtained from this series of experiments showed that generally the life of a rope working under such conditions was only one-half that of a similar rope bent in one direction only.

Fig. 1 is based upon the actual figures tabulated in Mr. Biggart's paper, while Fig. 2 shows the present author's approximations as obtained by the simple method of drawing fair and regular curves through or near the points representing the results of Mr. Biggart's experiments over such a range of pulley diameters (measured in terms of the circumference of the ropes) as obtain in general overhead crane practice. Several interesting deductions may be drawn from a study of these figures. The time of breakage of the first wires of a rope in the lowest curve is only recorded for one make of rope, but comparing it with the second curve, which shows the time of breakage of whole ropes of the same make, it will be seen that when the first wire breaks, the rope may be assumed to have passed through one-half of its life, and as no one knowingly works a rope until it breaks entirely, the breakage of even a few wires is a sign that a rope should be carefully watched and replaced by a new one at an early opportunity.

The effect of varying the proportions of diameter of pulley to diameter of rope is one of the most important features to be

noticed. Speaking generally, Mr. Biggart's experiments show that increasing the diameter of the pulleys by an amount equal to two circumferences of the rope will double the life of the rope. This is approximately correct for all the varieties of rope and conditions experimented with, and may therefore be taken as equally correct for all the varying conditions under which cranes are worked. It is very remarkable that so simple a rule should evolve from such numerous and varied experiments, and the author hopes that its statement in this form will be of some value to designers. That it is sufficiently correct for all practical purposes may be readily seen by referring to Fig. 3 where the ratios of pulley diameters to ropes are plotted as abscissas to a linear scale, while the durability of the ropes is represented by ordinates drawn to a logarithmic scale.

These conclusions enable one to express a definite value for the effect upon the durability of ropes, of the various arrangements of pulleys that are commonly adopted in overhead cranes, some of which are illustrated in Figs. 5 to 11. Assuming that Fig. 6 (in which the ropes make three bends in working, namely, one at the upper drum and one on each side of the lower pulley, *i. e.*, at entering and leaving) is the arrangement most frequently adopted in practice, and representing the anticipated life of the rope under these conditions by 100, then the relative lives of the ropes in each of the other arrangements indicated are as shown in Table I.

TABLE I. COMPARISON OF ANTICIPATED LENGTH OF LIFE OF ROPES ARRANGED AS SHOWN IN FIGS. 5 TO 11

Fig. No.	No. of Bends	Relative Life of Rope
5	1	300
6	3	100
7	3*	75
8	7	43
9	11	27
10	7*	37½
11	11*	25

* Including one reverse bend which is twice as effective in wearing out the rope.

If it be desired to design each of the above arrangements of pulleys so that the ropes shall have equal durability, then the ratio of the drum diameters to rope circumference (if the law indicated by Figs. 2 and 3 is to be relied upon) must be increased as shown in Table II.

TABLE II. REQUIRED INCREASE IN DIAMETERS OF ROPE DRUMS (MEASURED IN TERMS OF CIRCUMFERENCE OF ROPE) REQUIRED TO GIVE EQUAL DURABILITY

Fig. No.	Increase over Diameter called for by Fig. 6
7	1 Circumference of Rope.
8	2½ Circumferences of Rope.
9	4 " "
10	3 " "
11	4 " "

It is quite usual for purchasers to specify in their inquiries that the diameters of the pulleys and drums must bear a certain relation to the diameter of the rope, but the author wishes now to emphasize the point that this stipulation is not sufficient in itself without some consideration being also given to the arrangement of the rope and pulleys.

If the generally accepted ratio of seven circumferences, or twenty-two diameters, of the rope for the diameter of the barrel be assumed as suitable for the drum and pulleys arranged as in Fig. 6, then the diameters for the other figures, to give equal durability, should be as shown in Table III.

TABLE III. RATIO OF DIAMETER OF PULLEYS AND DRUMS TO CIRCUMFERENCE OF ROPE TO GIVE EQUAL DURABILITY

Fig. No.	Ratio of Pulley and Drum Diameter to Rope Circumference
5	4 to 1
6	7 to 1
7	8 to 1
8	9.5 to 1
9	11 to 1
10	10 to 1
11	11 to 1

To make the comparisons quite fair between the different arrangements, it must now be pointed out that owing to the increased number of falls of rope adopted in Figs. 8 and 9, the size of the rope may be reduced as shown in Table IV, while retaining the same factor of safety.

TABLE IV. RELATIVE ROPE CIRCUMFERENCE ALLOWING FOR SMALLER ROPES DUE TO INCREASED NUMBER OF FALLS

Fig. No.	Number of Falls	Relative Rope Circumference
5	2	140
6	4	100
7	4	100
8	8	70
9	12	57
10	8	70
11	12	57

Combining the figures given in Tables III and IV will give drum and pulley diameters as shown in Table V.

TABLE V. DRUM AND PULLEY DIAMETERS RESULTING FROM A COMBINATION OF TABLES II AND IV, AND STILL ASSUMING THAT 100 REPRESENTS THE CONDITION IN FIG. 6

Fig. No.	Ratio of Pulley and Drum Diameter to Rope Circumference according to Table III	Relative Circumference of Rope as per Table IV	Resultant Pulley and Drum Diameter assuming Fig. 6 = 100
5	4	140	80
6	7	100	100
7	8	100	114
8	9½	70	95
9	11	57	90
10	10	70	100
11	11	57	90

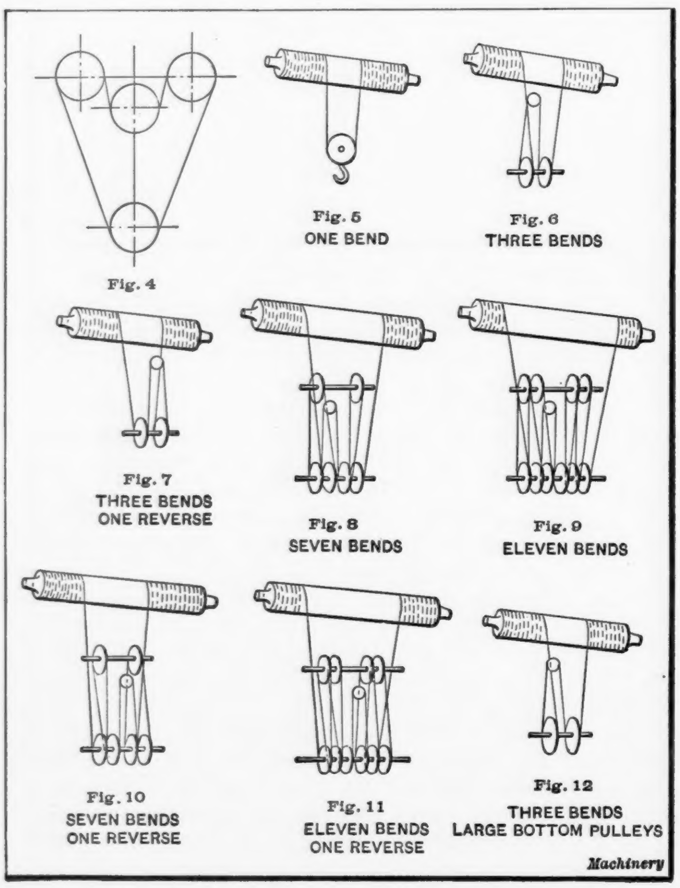
The noticeable feature in the last table is that whether two, four, or six falls are adopted, the diameter of the drum and pulleys should remain about the same, if the ropes are to have equal durability. A recent text-book upon the subject of crane design states (as an advantage of a large number of falls of rope) that the proportionately larger pulleys and barrel will insure *long* life for the ropes, but the author hopes that he has made it clear that very large proportions are necessary to insure a *reasonable* life for ropes on cranes with many falls of rope. Reference to Table V shows also the increase that should be made in the diameter of the drum and pulleys if a reverse bend occurs in the run of the rope.

Another important detail in crane design may now be referred to. In Fig. 6, as already mentioned, the ropes make two bends at the lower pulleys to one at the drum, and therefore, if the lower pulleys are made of the same diameter as the drum they will be responsible for two-thirds of the wear and tear of the rope. Now it is usually difficult to increase the diameter of the working barrel or drum of a crane, because to do so affects the ratio of the gearing and also requires a much larger framework with a corresponding increase in the cost of manufacture; but, if it is agreed, as a result of Mr. Biggart's experiments, that increasing the diameter of the pulley over which a loaded rope passes, by an amount equal to twice the circumference of the rope, reduces the evil effects of bending the rope round it to one-half, then a simple means of improving the durability of crane ropes is immediately at the disposal of the designer, namely, to increase the diameter of the pulleys in the blocks, leaving the drums of the original size, as indicated in Fig. 12. This change can usually be effected without serious alteration of the design, and may even be carried out on existing cranes. The result of increasing the diameter of the pulleys by an amount equal to two circumferences of the rope will be that the effect of the double bend round the lower pulley is halved, the resultant effect of the three bends will be equal to two only, and the relative life of the rope will be increased by 50 per cent; or the drum diameter might be reduced by an amount equal to 1.2 times the circumference of the rope with a corresponding reduction in the size of the framework of the crab or winch, while still retaining a relative life for the rope equal to that in Fig. 6. In this case the diameter of the lower pulleys would only require to be about one circumference of the rope larger than the original size of Fig. 6.

In making the foregoing comparisons of diameters of drum and pulleys with different arrangements of rope it has been assumed that the hook is raised to the full height available at each lift. This, however, is not the case in actual practice, the majority of loads not being raised one-half this height. This consideration brings to light another great advantage of the design in Fig. 12 as compared with any of the others.

Where, as is usually the case, the average height of lift in a shop does not reach half the maximum available, then that portion of the rope which passes under the lower pulley does not reach the upper drum, and accordingly is only subject to the wearing action of the two bends at the lower pulley. If, therefore, the effect of the bends at the lower pulley is reduced to one-half, by the proposed increase in diameter of the pulley, then the actual life of the rope will be doubled, instead of only being increased by 50 per cent, as was first assumed.

Where there are more than two falls of rope, as in Figs. 8 and 9, the effect of increasing the diameter of the pulleys by an amount equal to two circumferences of the rope is also very marked, reducing the effect of the seven bends in Fig. 8 to that of four and a half, with corresponding increase in the lift of the ropes. This shows up the fault of those designers



Figs. 4 to 12. Various Arrangements of Drums and Pulleys in Lifting Appliances

who adopt large drums (in order to obtain the great length of rope entailed by high lifts) and are yet content to make the pulleys of small sizes, when they could enormously increase the durability of the rope by the adoption of larger pulleys at little extra cost.

When the rope makes a reverse bend at the barrel as in Figs. 7, 10, and 11, the barrel ought to be increased in diameter to counteract the effect of the reverse bend. Thus, if in each of these cases the diameters of the drums were made larger by an amount equal to two circumferences of the rope, the durability of the rope would be equal to that in Figs. 6, 8, and 10, respectively.

Some Continental makers point out, very rightly, the desirability of making the compensating pulleys of reasonable size. The motion over such pulleys is apparently considered as negligible by some designers (judging by the forms of construction adopted), but this point of view overlooks the movement of the rope due to the swinging of the load, and the repeated bending of the rope at the same place over a small radius has an appreciable effect upon the durability of the rope.

Although the deductions laid down here appear too simple to need elaboration, a glance at the designs of many modern cranes shows that neither the designers, nor the purchasers, are aware of the importance of the principles involved; otherwise we should not see modern cranes with reverse bends in the ropes, and as many as eight plies of rope to carry the load on cranes of only 15 tons capacity.

The qualities of wire used vary considerably, and this, together with the heat-treatment in manufacture and the care taken by the makers in testing and examination, are questions that makers of ropes are in a better position to discuss than users. The "lay" of the strands and the lubrication of the rope when in use have each a considerable effect upon durability, and some guidance on these points may be obtained from Fig. 3, where "Lang's lay" is shown to have more than double the life of ropes of ordinary "lay," and ropes that are oiled last more than twice as long as when this precaution is neglected, as already mentioned. The superiority shown by "Lang's lay" naturally gives rise to the question as to why it is not exclusively used, and the answer the author has obtained from rope-makers is that such ropes must be very carefully handled to avoid "kinks," and they are also found to be more liable to "spin."

* * *

STATE TRADE SCHOOL OF BRIDGEPORT

The State of Connecticut maintains two trade schools, one of which is located in Bridgeport. The purpose of the Bridgeport school is to teach the methods of machine making, cabinet making, pattern making, drafting, machine shop practice, toolmaking, printing and plumbing.

Several plans of instruction are followed, such as day school, continuation school, and half-time school. In addition, there are vacation and evening schools. The day school course extends over two years, comprising 104 weeks of 49 hours each. The continuation school gives four hours instruction per week to apprentices employed in local factories. Each student is paid his regular wage scale by the factory while in school, and the time is employed in educational work to supplement the training he is receiving in the factory. The half-time school takes care of apprentices who alternate between the shop and the school, being employed at the factory one week and sent to the school the next. The school time is applied on their apprenticeship and the apprentice time is applied on school hours.

Each day of instruction received on the machine shop course is made up of 6½ hours shop work, one hour drafting, ¾ hour applied mathematics, ¾ hour applied science and mechanics. Shop lectures and inspection trips are given at times. In the continuation school the four hours are divided into drafting, 2½ hours, and trade mathematics, 1½ hour. In addition, the teacher occasionally visits the factories so as to keep in touch with the specific needs of each pupil. The students in the half-time school spend half of their time at their trades and the other half in school. They are rated as regular day students and receive the same instruction. Each student must finish one year of regular school training before being entered in this school. There is no charge made to students from any part of the State of Connecticut, nor are there any entrance requirements, save that the students must be fourteen years of age. The school is under the direction of Superintendent Frank L. Glynn.

* * *

HORSEPOWER AND KILOWATT

The British Association for the Advancement of Science adopted, as early as 1873, 746 watts as the equivalent of the British and American horsepower, and 736 watts as the equivalent of the metric or Continental horsepower. In a circular recently issued by the United States Bureau of Standards, it is stated that in all future publications of this bureau the former value, 746 watts, or 0.746 kilowatt, will be used as the exact equivalent of the English and American horsepower. For scientific work, it is quite important to have the horsepower thus standardized by being expressed in the so-called "absolute" system of measurement, because the common definition of 550 foot-pounds per second is scientifically correct only at a certain latitude and altitude, on account of the fact that the pound-weight, as a unit of force, varies in value as g, the acceleration of gravity, varies. The horsepower when expressed as 746 watts is equal to 550 foot-pounds per second at 50 degrees latitude and at sea level.

BALANCING AUTOMOBILE ENGINE FLYWHEELS

One of the essential points to be observed in the manufacture of a smooth-running and efficient automobile engine is to put all the moving parts in perfect balance. In the following is described the method employed by the White Co., Cleveland, Ohio, maker of high-grade automobiles and motor trucks, for balancing the flywheels used on its engines.

The first operation called the "static balance test," is carried out in the manner illustrated to the right in Fig. 2.

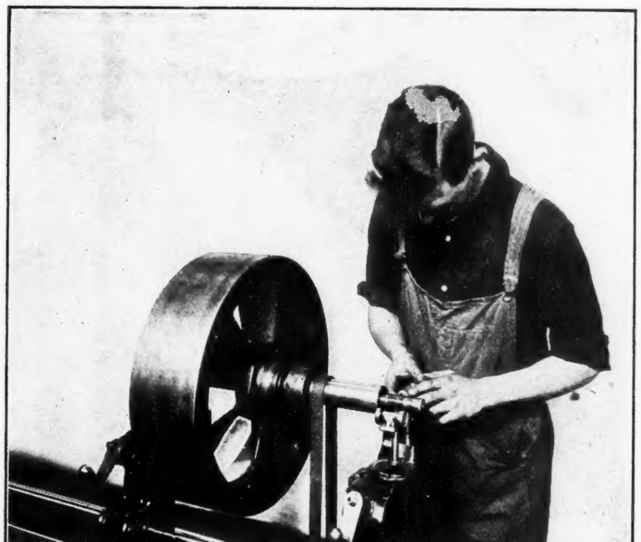


Fig. 1. The Final or Running Balance Test accomplished on a Norton Balancing Machine

Here the flywheel to be balanced is held on a hardened and ground arbor, the latter being located on knife-edges which form an integral part of the balancing stand. The stand has four legs, rigidly braced. When balancing, the operator lets the flywheel oscillate, watching it until it comes to rest. That part of the wheel which is heaviest, of course, always goes to the bottom. A piece of putty is then put on the inside of the rim opposite the heaviest side, and the flywheel is again tried and more putty added, if needed, until a close approximation to a perfect balance is obtained.

The next operation consists in removing the required amount of material from the heavy side of the rim to secure the proper balance. This operation is shown in the center of Fig. 2. The operator places the flywheel on a fixture which is tilted at an angle and is provided with a stud for holding it. The material is removed with a twist drill from that portion of the rim diametrically opposite the chunk of putty. To ascertain the amount of material to remove, the putty is placed on a scale, as shown in the foreground, and the drillings are collected and put on the other pan of the scale. A sufficient amount of material is removed to balance the putty.

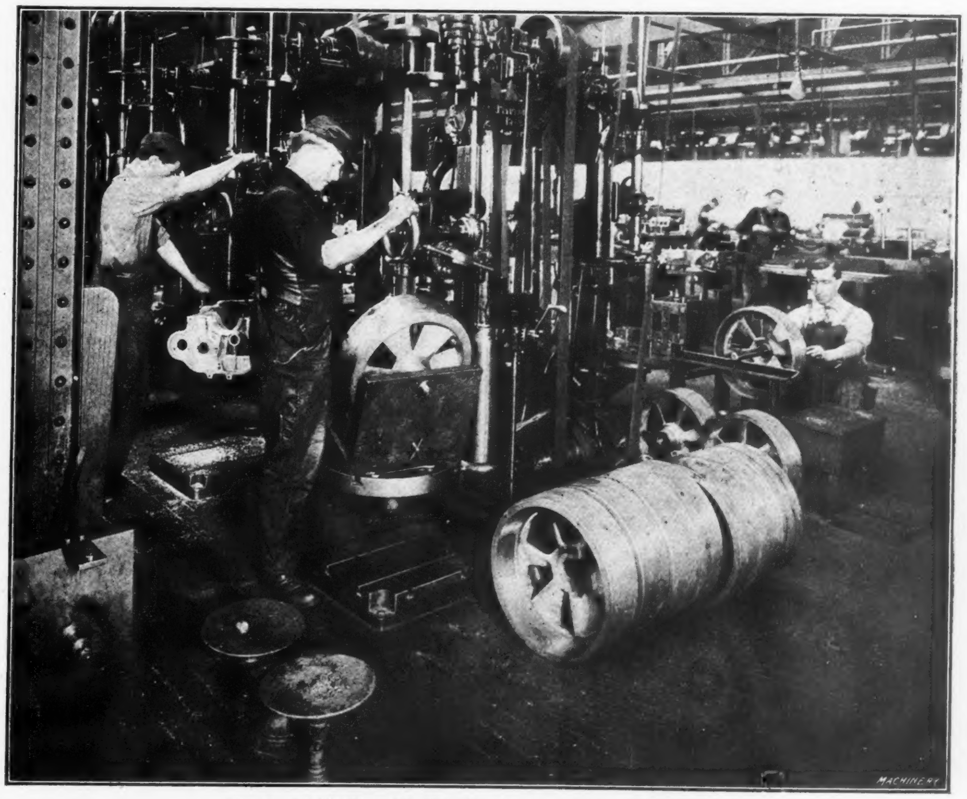


Fig. 2. Subjecting the Flywheel to the Static Balance Test

In the balance test just described, the flywheel is not rotated at a high rate of speed, but is put into the condition known as "static balance." To insure its being in perfect balance when the engine is running, it is next given a running balance. This is accomplished on a Norton balancing machine as illustrated in Fig. 1. The flywheel is again placed on an arbor, the extreme ends of which run on four pairs of rollers, and is rotated by a belt as shown in the illustration.

In order to see where the flywheel is out of balance, the small end of the arbor is coated with red lead, and as it is rotating the operator brings a copper pencil, held in a swinging member, in contact with the arbor. The points on which the pencil bears heaviest indicate the side of the rim from which it is necessary to remove material to make the flywheel balance properly when in service. From the foregoing it will be seen that by following this procedure a flywheel is obtained which aids in producing the much-desired smooth-running automobile engine.

D. T. H.

* * *

LORD KELVIN MEMORIAL WINDOW SUBSCRIPTION

The engineering societies of the United States are receiving subscriptions for a memorial window to be erected in Westminster Abbey, London, to the memory of the late Lord Kelvin, the distinguished scientist and engineer. Lord Kelvin, formerly Sir William Thomson, was the inventor of the first successful receiving galvanometer for ocean cables, which is a marvel of sensitiveness. His work in the development of testing and recording apparatus for cables made submarine telegraphy a great success. The general committees formed to carry the plan into effect embrace representation from eight engineering societies in England, Ireland, Scotland, America, Canada, Victoria, South Africa and South Australia, and its chairman is William Cawthorne, Unwin, London. The societies represented are: The Institution of Civil Engineers, The Institution of Mechanical Engineers, The Institution of Electrical Engineers, The Institution of Naval Architects, The Iron and Steel Institution, The Institution of Mining and Metallurgy, The Institution of Mining Engineers, The North-east Coast Institution of Engineers and Shipbuilders, all of England; The Institution of Civil Engineers of Ireland; The Institution of Engineers and Shipbuilders in Scotland; The American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, The American Institute of Mining Engineers, The American Society of Naval Architects and Marine Engineers, in the United States; The Canadian Society of Civil Engineers in Canada; Members of the Institution of Civil Engineers in South Africa; and Members of the Institution of Civil Engineers in South Australia.

DOGS AND DRIVERS FOR LATHE WORK

A REVIEW OF THE VARIOUS DESIGNS OF DRIVERS FOR WORK HELD BETWEEN CENTERS

BY H. E. WOOD*

The lathe dog constitutes such an important part of the equipment of a machine shop, and there are so many different types of these devices in use, that it may be of interest to mechanics to follow the writer in a brief review of the most commonly used designs. Many of the lathe dogs shown in the following have been made for special purposes. It may appear that they are not of great utility, but in emergency cases, under special requirements, they have been found useful. A brief reference will be made to each of the lathe dogs shown. The illustrations show clearly the construction, and there is little need for a detailed description.

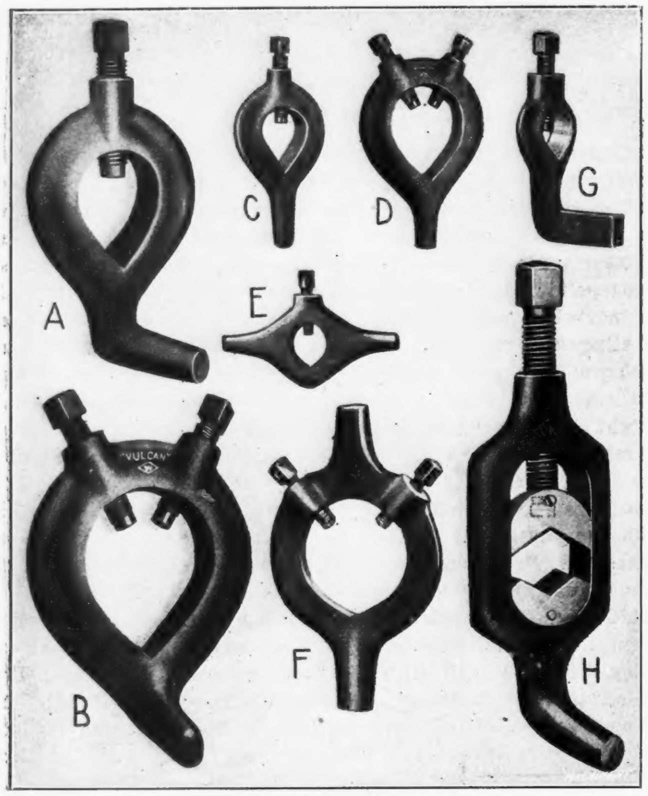


Fig. 1. Miscellaneous Examples of Lathe Dogs

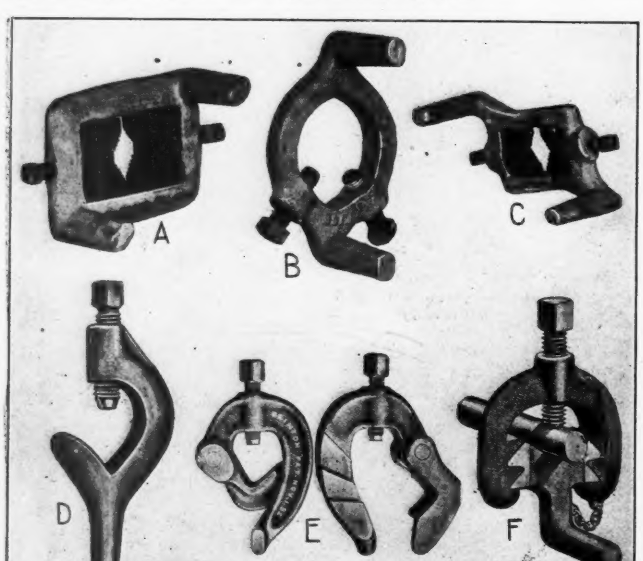


Fig. 2. Lathe Dogs of Special Construction

At A in Fig. 1 is shown one of the most commonly used lathe dogs—that with a bent tail and a single screw. At B is shown the same type of dog, but having two screws. At C is shown what is called a straight-tail dog with one screw, and at D the same dog with two screws. When these latter dogs are used, a stud driver, of course, is employed to drive against the tail. At E and F are shown double-tail dogs with one and two screws, respectively. At G is shown a dog which, although similar to that shown at A, has a flat tail with parallel sides.

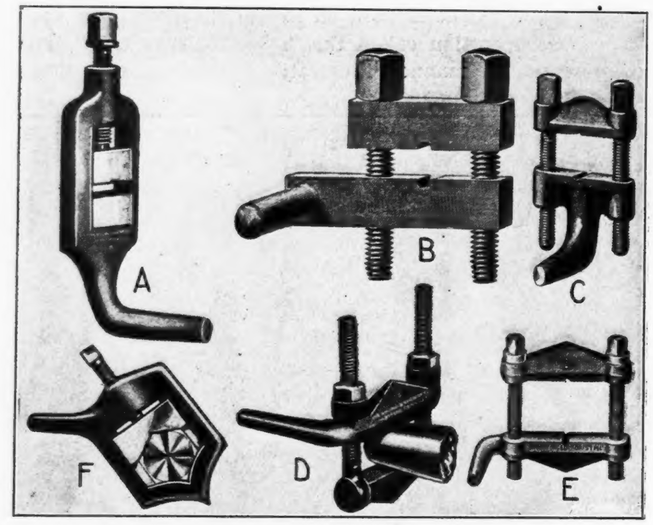


Fig. 3. Die Dog, Clamp Dogs, etc.

This type of dog is used in the milling machine rather than in the lathe, the flat tail making it convenient to secure it with a set-screw when used in the milling machine.

A dog somewhat different from those previously shown is illustrated at A in Fig. 3. This is called a die-dog because of its similarity to a thread-cutting die. At H in Fig. 1 is shown the so-called "O. K." design of dog. The design of these two dogs is intended to prevent the binding screws from marking the work. At A, B and C, Fig. 2, are shown three double-tailed dogs designed by the Fitchburg Machine Works, which are especially adapted to the Lo-swing lathe made by that company. The prime object of double-tailed dogs is to equalize the pulling strain on the dog on both sides of the center. This relieves the work of undue side strain. At D in the same illustration is shown a type of dog called an open-side dog because of the opening at one side which permits of the dog being put onto the work after it is placed on the centers. At E is shown the Brinton patented dog which can be slipped on and off the work while it is on its centers, and at F is shown a type of dog made in two parts. This dog is adjustable for size, as indicated, there being three possible positions of the lower part within the upper. It is patented by Mr. Richmond Parsons. At B in Fig. 3 is shown a very common type of clamp dog, and at C the same type of dog with bent tail. At D is shown another dog of similar type, but in this design the lower jaw can swivel so as to accommodate tapered work. At E is shown still another type of the clamp dog class. At F in Fig. 3 is shown a type of patented dog made by the Western Tool & Mfg. Co. Fig. 4 shows what is called a reduction dog.

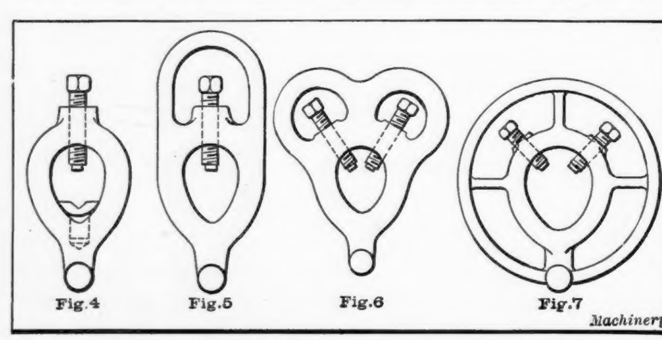


Fig. 4. Adjustable Dog. Figs. 5 to 7. Safety Dogs

Figs. 5, 6, and 7 show three types of dogs with protected screws. It is rather difficult to guard the set-screw on the lathe dog properly so that it cannot cause injury to the operator, but these illustrations indicate what can be done. Fig. 8 shows a somewhat unusual type of double-tail dog provided

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with inserted shoes to assist in the holding of the work. This dog is patented by Mr. William L. Reid. Fig. 9 shows an elaborate type of what is usually termed a hold-back dog. Its object and the manner in which it is used is clearly shown in the engraving, it being used on work where one end runs in a

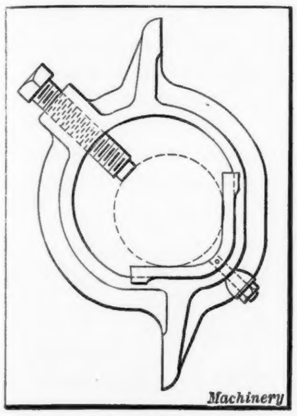
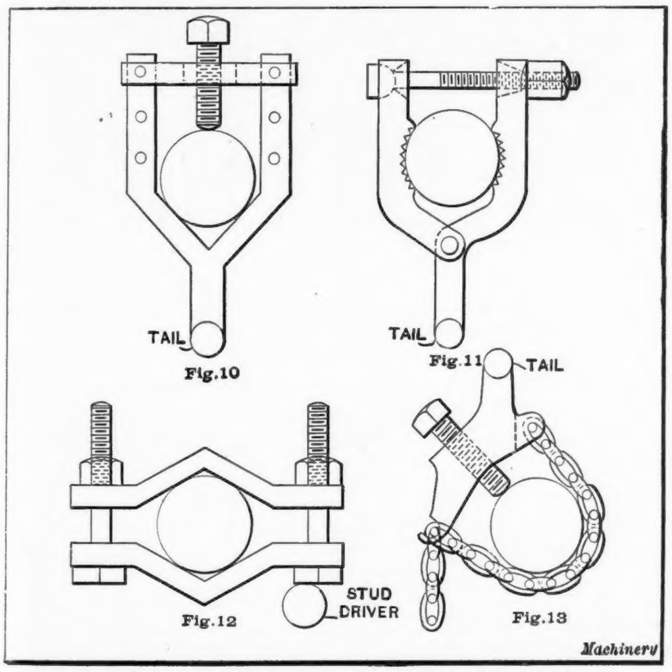


Fig. 8. The Reid Lathe Dog

steadyrest, to hold the work against the lathe center. The springs back of the faceplate give the required elasticity to the entire tool. This device eliminates the use of the belt-lace or lashing process which is more or less unhandy. This lathe dog was patented by Mr. Milton B. Hill. In Fig. 10 is



Figs. 10 to 13. Miscellaneous Dogs of Special Construction

shown a "homemade" type of dog. The cross-bar is forked where it fits over the side bars. Fig. 11 shows a dog with corrugated jaws, jointed as indicated. This dog is very convenient for certain purposes. Fig. 12 shows a popular type of driving dog. Dogs of this kind are usually made to suit im-

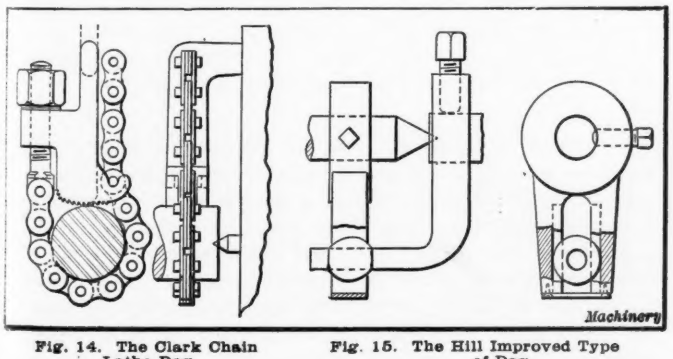


Fig. 14. The Clark Chain Lathe Dog

Fig. 15. The Hill Improved Type of Dog

mediate requirements. Fig. 13 shows a peculiar form of adjustable chain dog. This dog has a capacity for a wide variety of sizes according to the length of the chain. Fig. 14 shows a similar kind of dog patented by Mr. Hugh Elmer Clark, the claim for this dog being that it is easily attached to and detached from the work without removing the latter from the centers.

In Fig. 15 is shown a dog which is more especially adapted for the milling machine, and which is intended for taper work

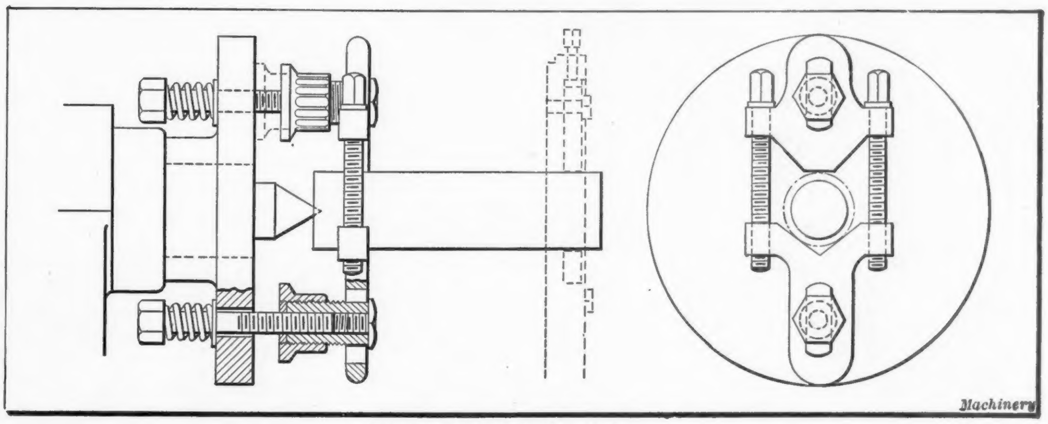


Fig. 9. The Hill Hold-back Dog

when it is necessary to have a radial and transverse movement and at the same time have no backlash in the rotating direction. This dog is patented by Mr. Milton B. Hill.

Fig. 16 shows a dog specially designed for use when producing a large number of pieces of the same size. This dog is termed a faceplate dog, principally because it is secured to the faceplate of the lathe. It is patented by Mr. Adam Tindel. Fig. 17 shows a dog which operates without screws. It is quick-acting, but can drive in one direction only. This design is patented by Mr. Thomas C. Thompson. Fig. 18 shows a dog especially devised for driving work which has irregular surfaces of any sort. It is patented by Mr. Louis Goddun. Fig. 19 shows a lathe dog which can be tightened without a wrench. It is patented by Mr. Frank L. Osgood. It can be attached to and detached from the work without removing the latter from the lathe. Fig. 20 shows a very simple but strong and efficient dog which can also be attached to and removed from the work

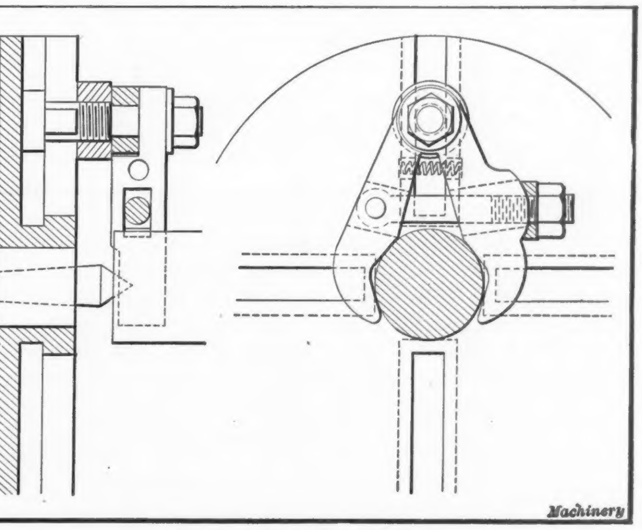


Fig. 16. The Tindel Lathe Dog

while the latter is held between centers. Fig. 21 shows a number of types of clamp dogs. The one at *A* has brass-faced clips to protect finished work from being marred. The dogs shown at *E* and *F* are also provided with soft jaws for protecting the work. Those shown at *D*, *E* and *F* are intended to be self-balancing dogs for grinding machines.

In addition to the devices illustrated, there are shown in the following some devices which can hardly be classed as dogs, but which are merely makeshifts used in place of dogs. Fig. 22 shows a very common method of driving a piece of lathe work, the device consisting of two V-blocks clamped onto the work with an ordinary C-clamp. In Fig. 23 the clamp is used with its screw directly on the piece being turned. It will be noticed that the center line of the screw is a trifle in front of the center line of the work and that there is a block behind the work. This arrangement has been adopted in order to insure

that the screw will not work off the shaft. The use of a stud driver in the faceplate of the lathe is, of course, necessary when these methods are employed. Fig. 24 shows another commonly used method where either a wooden or iron parallel clamp is screwed onto the shaft or work.

Fig. 25 shows a cheap makeshift which is often resorted to. This dog consists simply of a piece of scrap iron with a hole

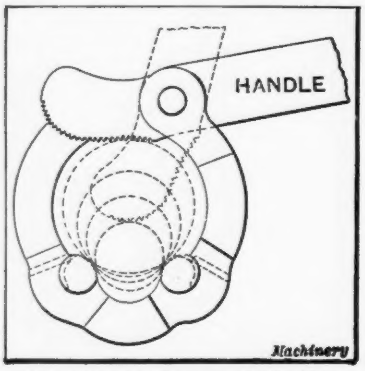


Fig. 17. The Thompson Lathe Dog, which operates without Screws

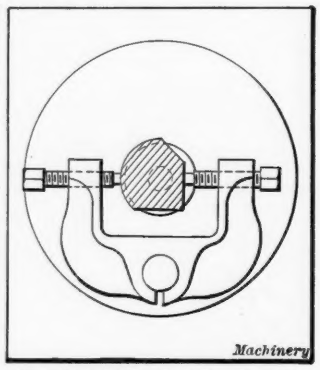


Fig. 18. Lathe Dog for Irregularly Shaped Work

through it, large enough to take the work for which it is wanted. Fig. 26 shows another makeshift consisting of a common collar with an extra set-screw in it and a hole drilled for a piece of round iron driven into the collar and used as a tail. Fig. 27 shows a threaded lathe dog with a split hub and binding screw. When work is threaded on the end, the diameter of the thread being the same as that in the dog, the latter can be screwed onto the work and clamped by the binding screw so as to drive the work without injuring the thread. Fig. 28 shows another type of dog with a threaded hole in it. This dog is intended to be placed on the ends of studs or pieces made in the screw machine, or on any piece not having

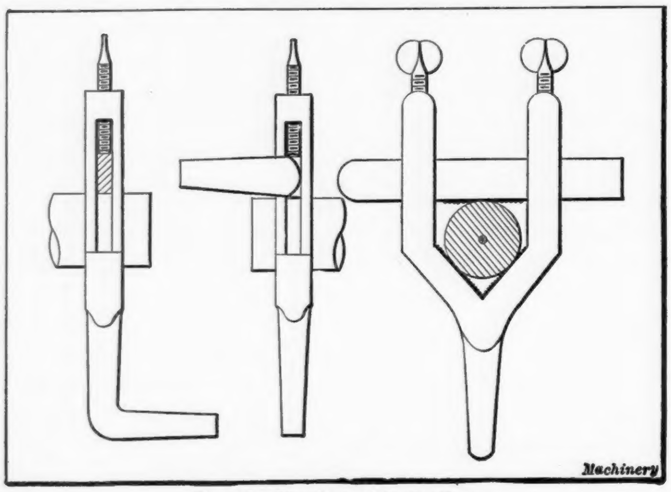


Fig. 19. The Osgood Lathe Dog

a center. Fig. 29 shows another cheap, "homemade," open-side, adjustable dog. This type is made from a round piece of cold-rolled steel, bent as shown. Three pin-holes are drilled through it so as to receive the pin which holds the head, which is adjustable from one position to another. Fig. 30 shows a simple method of driving a piece of work, the dog consisting merely

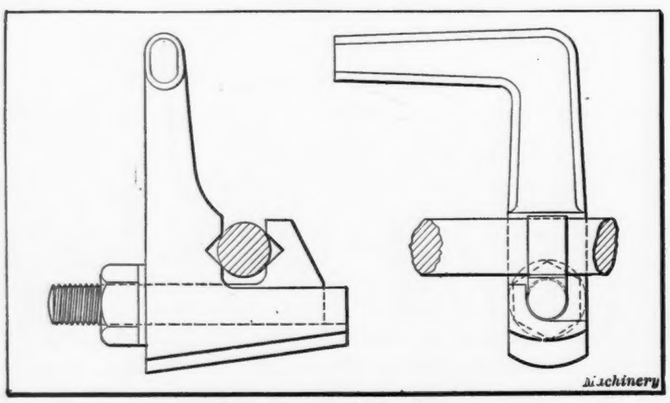


Fig. 20. Type of Open Dog

of a piece of flat iron bent over to suit the work, with a bolt for binding as shown. Fig. 31 is another type consisting merely of a piece of flat iron, bent as required and drilled and tapped for a set-screw. Fig. 32 is especially intended for use on finished work, when one wishes to avoid any marks which might be made by the lathe dog.

There are, of course, innumerable devices that have been made for special purposes, but those shown are typical and indicate what may be done. In addition there are, also, of course, a number of drivers used on faceplates for driving chucked work not held between the centers. These, however, are not strictly lathe dogs, and as they are often made to suit special requirements and have hardly any common characteristics, they are not dealt with in this connection.

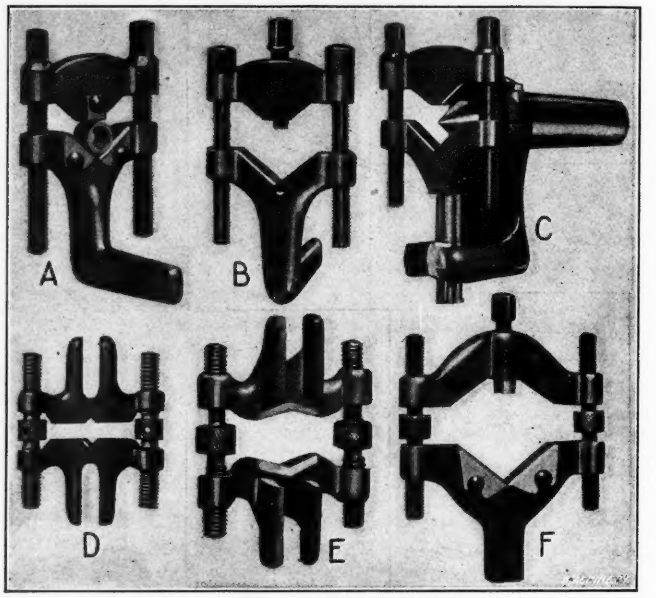
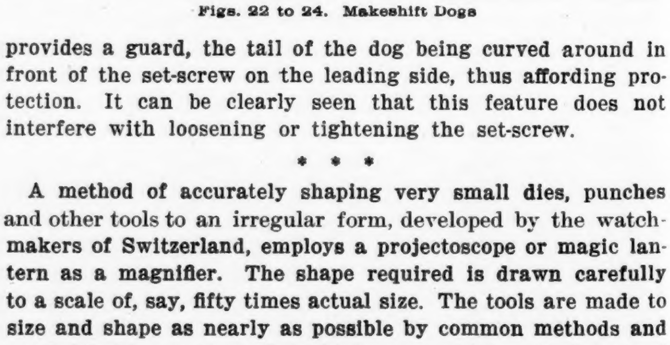


Fig. 21. Hill Clamp Dogs

In Fig. 33 is shown a safety lathe dog which has been brought out by Elmer J. Michaud of South Windham, Conn. Every machinist who has operated a lathe realizes the danger incident to the use of the ordinary lathe dog with its unguarded set-screw, which tends to catch in the clothing, especially when filing. This lathe dog is so shaped that it provides a guard, the tail of the dog being curved around in front of the set-screw on the leading side, thus affording protection. It can be clearly seen that this feature does not interfere with loosening or tightening the set-screw.



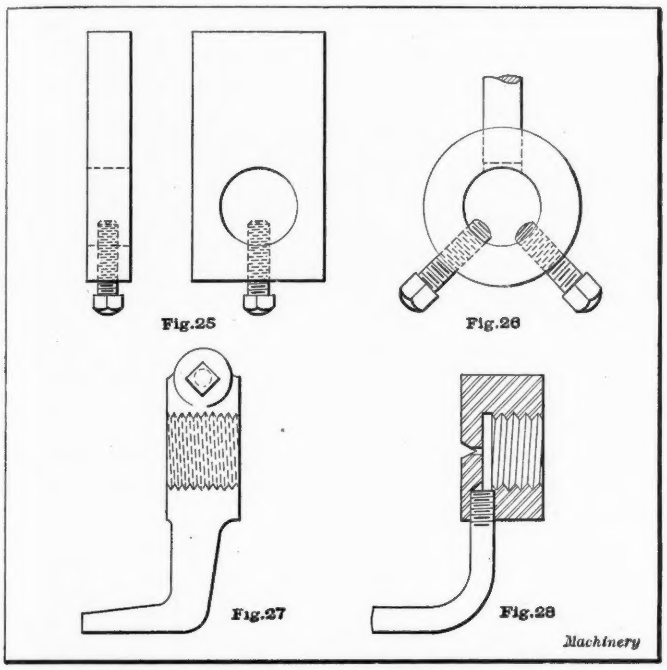
Figs. 22 to 24. Makeshift Dogs

* * *

A method of accurately shaping very small dies, punches and other tools to an irregular form, developed by the watchmakers of Switzerland, employs a projectoscope or magic lantern as a magnifier. The shape required is drawn carefully to a scale of, say, fifty times actual size. The tools are made to size and shape as nearly as possible by common methods and are finished by stoning off the high parts which extend beyond the limits of the drawing when projected on it by the lantern. The inaccuracies are thus multiplied fifty times and the spots that do not coincide with the drawing are stoned off by a specially devised grinding rig that is controlled by the toolmaker, the tool being worked down without removing it from the lantern.

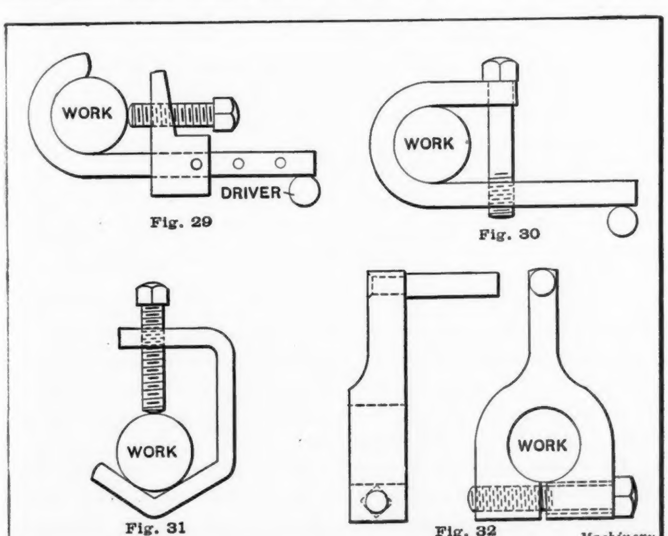
CONGRESS OF INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

The sixth congress of the International Association for Testing Materials was held in the Engineering Societies Building, New York City, September 2 to 7. Twenty-four nations were represented in the congress, the various foreign governments, as well as engineering societies here and abroad, having sent delegates. The object of the society is to further the progress of engineering by augmenting the knowledge relating to materials, by devising proper means and methods for the testing of materials, by drawing up specifications for materials for various purposes, and, in general, by providing standardized and uniform methods of engineering practice, in as far as the properties of materials of construction are concerned.



Figs. 25 to 28. Other Examples of Makeshift and Special Dogs

The congress was divided into three sections: one on metals, with a sub-section on cast iron and special steels; one on cement and stone; and one on miscellaneous materials. One hundred and fifty-three papers formed the program for the sixth congress. These papers related to hardness testing, to wear tests of steels, impact tests, corrosion tests for pipes, endurance tests, tests relating to magnetic and electric properties and properties of metals at high temperatures, tests on steel rails, cast iron and special steels, as well as tests on non-ferrous metals and alloys. Other papers relating to the investigation of new testing methods, micrography and micrographic researches, nomenclature of iron and steel products, as well as a considerable number of papers relating to cement, stone, paints, timbers, oils, road materials and rubber, were also presented.



Figs. 29 to 32. "Homemade" Dogs of Simple Design

The International Association for Testing Materials meets every three years in a congress devoted to the presentation and discussion of technical papers along the lines outlined. The last congress was held at Copenhagen, Denmark, in 1909. The preparations for the sixth congress have been in the hands of the American Society for Testing Materials, which is affiliated with the International Association. The social features included an informal reception under the auspices of the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining Engineers, on Monday, September 2, and an excursion on the Hudson River to the military academy at West Point on September 4. On September 5 there was a reception tendered to the foreign members by the American Society of Civil Engineers. For those of the foreign members who desired to see something of America and its industrial development, a special excursion hotel train was arranged after the adjournment of the convention, making a week's tour, visiting Washington, Pittsburg, Buffalo and Niagara Falls.

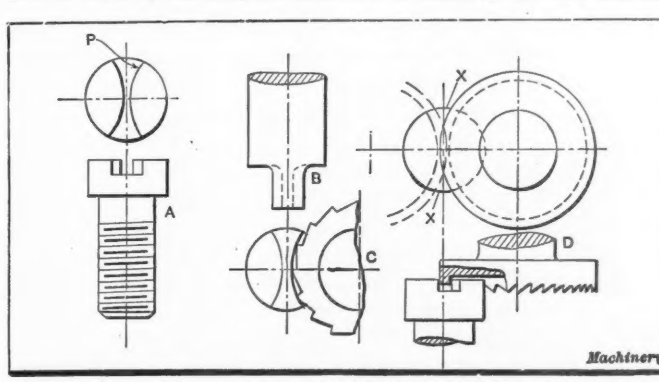
Fig. 33. Michaud Safety Dog

Before adjourning the congress elected as the new president of the International Association, Prof. N. Belelubsky of St. Petersburg, Russia, professor emeritus of the Institute of Engineers of Ways of Communication. The next international congress of the association will be held in 1915 in St. Petersburg.

* * *

UNUSUAL FORM OF SLOT IN FILLISTER-HEAD SCREW

An unusual form of slot in fillister-head screws is illustrated in a recent issue of the *Mechanical World*. This form of slot is used by an English firm and is claimed to have the advantage of providing a screw slot that is not likely to be injured; it also provides for a strong form of screw-driver.



Form of Screw-driver, and Screw-head Slot and Method of Producing It

In the illustration *A* shows the screw, *B* the screw-driver, *C* the cutter used for milling the screw-driver, and *D* the annular cutter employed for milling the slot in the screw head. It is evident that two milling operations with this cutter are required for each slot. In addition, an ordinary plain cutter must be run through in order to remove the piece *X*, which otherwise would remain at the ends of the slot. The screw head is strengthened in this way, it is claimed, because the pressure of the screw-driver is received in the direction of the arrow *P*, in which there is a better backing of metal to withstand the pressure. The slot is, in fact, of the same shape that an ordinary plain slot tends to assume after it has been used for some time.

CHARACTERISTICS OF WROUGHT-IRON

A REVIEW OF KINDS, USES, PECULIARITIES, AND METHODS OF TESTING

BY A. L. HAAS*

Wrought-iron has, to a very large extent, been superseded by mild steel. Nevertheless, a large field remains where its resistance to fatigue and the ease with which it can be welded renders it valuable. Where reliability is of prime importance, no other material is superior to it.

Yorkshire iron of the best quality is still made in large quantities. There is no finer commercial grade of iron to be obtained anywhere than the iron known as Lowmoor or Farnley. The iron made in Staffordshire is of a lower grade, and it is this quality of iron that is threatened with extinction by mild steel. The cost varies, of course, with the quality, the best Yorkshire iron demanding twice the price of low-grade Staffordshire iron.

There are some articles for which wrought-iron is always used, for example, crane chains, lifting hooks, locomotive draw gears, etc. Years ago marine engine shafting was invariably made from wrought-iron. The firm of Blair, of Stockton on Lees, one of the earliest makers of marine engines and one of the most conservative firms at the present time, still makes (or, at least, until very recently did make) its shafting from this material. It is a well-known saying on the Northeast coast that no ship with Blair engines has ever been known to break down at sea from a fractured shaft. Two leading makers of steam fire engines still use Lowmoor plate for their boilers. These boilers are subjected to a heavy duty in spite of their small size. In locomotive practice Lowmoor iron rivets are still used for the boilers.

Pieces of Wrought-iron having been subjected to the "Rams Horn" Test

Corrosion of Wrought-iron

The resistance of wrought-iron to corrosion is remarkable, in spite of any statements to the contrary based on short periods of comparative tests. At Delhi, in India, there is a monumental column of this material which is over one thousand years old. The writer is informed on good authority that in various humid parts of India native-made iron, whose origin is too far back to be definitely known, is still seen fully exposed to weather conditions. At the Epping church, near London, there are some exposed iron hand-rails, one hundred and fifty years old, the section of which has not been diminished below the margin of safety during this period. This iron was probably smelted and puddled in small quantities, using charcoal for fuel, from particularly high-grade and easily reduced ore.

Corrosion in iron takes place in layers on account of its fibrous structure. The make-up of an iron bar can be compared with that of a wire rope, the spaces between the wires being filled with a silicious matter, which latter is naturally more or less weather- or corrosion-proof. In the instance of the hand-rails at the Epping church, the structure is plainly apparent, as corrosion has left the rails knotted like the trunk of an old tree. The pitting characteristic of steel is absent in this ancient iron.

It is a fact admitting of no controversy that the use of mild steel for ship plates has reduced the life of the hulls by one-half, and a similar reduction in life has accompanied the adoption of mild steel for boilers. The writer has personally observed steel deck plates around hatches which were originally ⅜ inch thick, that in a fourteen-year old steamer had been reduced to a thickness of 1/16 inch over a considerable area. The same vessel had to have the entire engine and boiler room tank (top, floors and intercostals) renewed after the same period. The original 7/16-inch plate could in a great many places be perforated with a good blow from a sharp scaling hammer.

On the other hand, an old steamer called the *Dodo*, which used to ply regularly between Cardiff and Spain, and which was provided with one of the earliest iron hulls ever built, was 65 years old in 1900. It is still running, and, hence, is now 77 years old. A fireman who sailed in her, and subsequently with the writer, said that he was afraid to break coal in her lower bunker or to scrape up dust with his shovel, using undue violence, for fear he would break through the bottom. A similar steel hull would have been in the ship breaker's hands in half that length of time. In fact, wooden hulls last longer than these do. A collier trading between Newcastle and London was sold for a coal store hulk at the youthful age of 150 years. In many ports scattered throughout the world old British wooden ships converted into stationary hulks can frequently be seen.

Present-day Tendency to Reduce First Cost and Increase Cost of Upkeep

It seems to the writer that the present-day tendency is to reduce the first cost, increase the cost of upkeep, and decrease the length of service without corresponding advantages, by the use of newer materials. Of course, circumstances alter cases, and there are instances where economy is of no account. There is a works in the Birmingham district in England which was recently taken over by an up-to-date concern. In these works there was a beam engine built by Bolton & Watt, which must have been about eighty-five years old. It was found advantageous to run this antique engine as the sole means of power. The engine cost nothing and the new concern built its furnaces with boilers mounted over them, and hence obtained, as one might say, for nothing, easily twice the amount of steam that could be used. The economy of modern engines, or of producer gas, is of no interest to this firm. The fuel has to be burned anyway, and the waste of steam is of no moment.

One of the largest users—as distinguished from producers—of wrought-iron, who employs this material exclusively in the articles of his manufacture, has a strong belief that there will come a revival in its use; yet this man does not belong to the old school, but is a live, prosperous man under fifty. Could some newer process of puddling be devised to produce larger quantities at a single operation, the use of wrought-iron would certainly be extended and its price reduced.

Peculiarities of Wrought-iron

In testing wrought-iron some peculiarities have come to the writer's notice. Best Yorkshire (Lowmoor and Farnley) if nicked ⅛ inch deep around, say, a 1-inch bar, with a sharp set, and broken short over the anvil with a single blow, shows a curious fracture. The bar breaks dead short and square. The fracture is coarsely granular, resembling badly burned steel, only the granular structure is coarser. The bar nicked on one side only, and carefully bent with the nick a couple of inches from the edge of the vise or anvil, shows a beautiful gray, silky, fibrous structure, free from crystals and perfect in every way. Only the best Yorkshire iron shows this peculiarity, which to the writer's knowledge has never been satisfactorily explained.

Some peculiarities have been noted in connection with the welding of wrought-iron. The lower grades make an ap-

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parent weld at almost a melting temperature, as well as at low heat. With the better grades of iron, however, this cannot be done, and a heat between closer limits of temperature is necessary. Hence, this kind of iron needs a careful and competent blacksmith, and he must give closer attention to his work than with the cheaper grades. A burned weld and a partial shut cannot pass even a cursory glance, as would similar welds in common grades of iron. Another point with regard to welding is that the less the iron is worked at the weld, the better the job. The writer has seen welds that have been reduced several tons in tensile strength by a smith unversed in this part of the art, unnecessarily working the weld at a comparatively low heat to make a good looking job.

Testing Wrought-iron

When mild steel is tested the strength "with" and "across" the direction of rolling is nearly equal, and for ordinary purposes of design can be so assumed. With wrought-iron, however, this is not the case. In bending tests, also, the angle

TABLE I. TENSILE STRENGTH AND ELONGATION OF WROUGHT-IRON BARS

Sectional Area	Yorkshire Iron		B B Staffordshire		B B B Staffordshire		Staffordshire	
	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent
1 square inch and under.	23	26	24	20–23*	23	23–25*	24	23
Above 1 square inch, under 4 square inches....	22	24	23	22	23	24	24	22
Above 4 sq. inches, under 8 square inches...	22	22	22	20	22	23	22	20
Above 8 square inches..	21	21	21	20	21	20	21	20
Channels, Angles, Tees.	22	21	22	15	23	15	22	15
Rivets..................	23	26	23	24	23	25	23	24

* Lower elongation: Rounds and squares $\frac{9}{16}$-inch and under; flats $\frac{7}{16}$-inch in thickness and under. Higher Elongation: Rounds and squares ⅝-inch and over; flat ½-inch in thickness and over, up to 1 square inch in area.

through which the iron can be bent with safety varies considerably, according to whether the bending is "with" or "across" the grain. The accompanying tables give a summary of the characteristics of wrought-iron, these tables being the results of long experience with this kind of material.

A number of wrought-iron pieces which have been tested in the manner that was commonly used years ago, and which still survives in some quarters, are shown in the accompanying halftone. Tests of this kind are known as "rams horn" tests, and are intended to indicate both the forging qualities of the iron and the closeness of the piling. A hole, 1¼ times the size of the bar or the thickness of the plate, is drifted hot from the solid, leaving the same distance clear from the end

TABLE II. TENSILE STRENGTH AND ELONGATION OF WROUGHT-IRON PLATE

Grade of Iron	Tensile Strength	Elongation in 8 Inches, Per Cent
Yorkshire.........	With grain, 21 tons Across grain, 19 tons	With grain, 20 Across grain, 12
Staffordshire BB ..	With grain, 21 tons Across grain, 18 tons	With grain, 10 Across grain, 5
Staffordshire BBB.	With grain, 22 tons Across grain, 18 tons	With grain, 12 Across grain, 7

or the side. The metal between the hole and the end of the bar is split with a sharp set from both sides and turned over as indicated in the engraving, the name of the test being derived from the appearance of the pieces after the bending is completed. When flat plates are tested, one horn is turned sideways and the other forward. Sizes up to two square inches in sectional area can be tested in one heat, but usually two heats are required. A second hole of the same size is drifted lower down the bar at right angles to the first. The test specimen, when cold, should show no defects, the piling should not split, and the surface of the "rams horns" should be free from red-short cracks. A clean fire, an experienced blacksmith, and considerable speed are required in order to make a satisfactory test, especially in the common grades of iron.

The only physical test bearing a direct relation to the prices and quality of iron is the reduction of area at the point of

TABLE III. COLD BENDING TESTS OF PLATE, ALL QUALITIES

Thickness of Plate, Inches	With the Grain, through Angle (in Degrees)	Across the Grain, through Angle (in Degrees)	Thickness of Plate, Inches	With the Grain, through Angle (in Degrees)	Across the Grain, through Angle (in Degrees)
1 and $\frac{15}{16}$	20	7½	½	42½	17½
⅞ and $\frac{13}{16}$	22½	10	$\frac{7}{16}$	50	20
¾	25	10	⅜	60	25
$\frac{11}{16}$	27½	12½	$\frac{5}{16}$	70	30
⅝	30	12½	¼	90	40
$\frac{9}{16}$	35	15	$\frac{3}{16}$	100	60

The inner radius of the curve at the bend not to exceed 1½ times the thickness of the plate.

fracture, when broken in a tensile strength test. In good iron this reduction of area should be 40 per cent. Two pieces of iron, one of which is twice as expensive as the other, will often have the same tensile strength and elongation, but the reduction of area will indicate which is the better iron. The best Yorkshire bar iron has been known to have over 60 per cent reduction of area, and usually it exceeds 50 per cent, but a cheap grade of bar iron rarely reaches 30 per cent. Good Staffordshire iron should have approximately 40 per cent reduction of area.

Chain made from Wrought-iron

As welded chain is one of the principal uses for which wrought-iron is still exclusively employed, a few remarks re-

TABLE IV. SPECIFICATIONS OF DRIFTING TESTS

Description of Iron	B B Staffordshire	B B B Staffordshire
Rounds up to 3 inches in diameter	Drift with grain to 1¼ times diameter, and across grain equal to diameter	Drift with grain to 1½ times diameter and across to 1¼ times diameter
Squares up to 3 inches side	Drift with grain equal to side of square, and across equal to ¾ times side	Drift with grain to 1¼ times side, and across equal to side
Rounds and squares over 3 inches diameter of side	Drift to ½ diameter or side	Drift to 1¼ times diameter or side
Flats up to 6 inches wide and under 1 inch thick	Drift to 2½ times thickness at a distance from edge equal to thickness	Drift to 2¾ times thickness at a distance from edge equal to thickness
Flats up to any width over 1 inch thick	Drift to 2 times thickness at a distance from edge equal to thickness	Drift to 2½ times thickness at a distance from edge equal to thickness

lating to the welding of chain of this kind may be of interest. In the making of high-grade crane chain, the value of the reduction of area cited above is clearly shown in the tests of the finished chain. The elongation of a good sample under tensile test bears a direct relation to the reduction of area obtained from the bar iron from which it is made. The greater the reduction of area in the bar, the greater the percentage of elongation in the finished chain.

A well made chain under tensile test never breaks in the weld, but always at the end of the link which is not welded, or at the side. A break at the weld proves poor workmanship, no matter what iron is used. If the chain is of the best quality of iron, and the workmanship is first-class, the chain should stiffen under the breaking stress so that it becomes solid like a piece of bar iron. This stiffening under a breaking load is a certain indication of quality. Chains made from

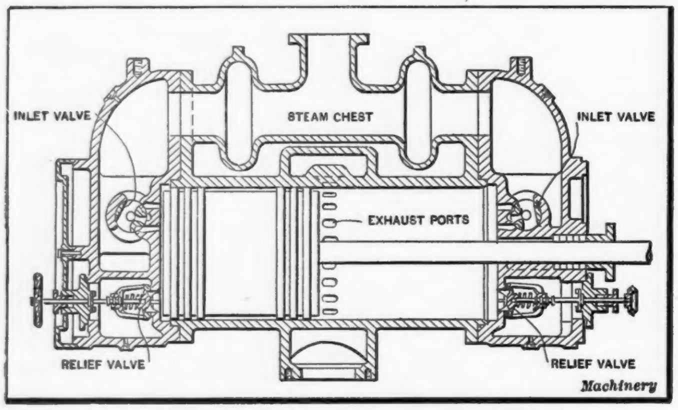
a common grade of iron do not stiffen. The stiffness is such that in good chain the end of the test piece can be held in the hand, and the test piece holds its own weight without movement or bending. If, when in use, a chain sling is found to lack freedom of movement, even to a slight degree, it should be discarded instantly because of the danger attached, as the chain must have been at some time overstressed.

A practical example of the value of annealing can be obtained from a wrought-iron chain by anyone. A link of such a chain of a good class of iron, say a sling chain, known to be in need of annealing, can easily be broken by a single blow of the hammer, with the link held vertically on the anvil. The fracture is coarsely crystalline and the break is sharp and nearly square. After proper heat-treatment the next link can be flattened or maltreated in almost any manner short of actually cutting it, but it will not break.

* * *

THE UNIFLOW STEAM ENGINE

The difference between the temperature of the live steam admitted to an engine cylinder and that of the exhaust leaving it makes the cylinder walls, cylinder head and piston act as reservoirs of heat which alternately fill and discharge at every stroke. The greater the ratio of expansion, the greater the difference in temperatures at the beginning and end of the stroke, and hence the greater the heat loss. This heat loss is commonly attributed to "initial condensation," but this phenomenon is simply the evidence of heat being imparted to the cylinder to raise it to the temperature of the incoming live steam. The abstraction of heat from saturated steam immediately causes condensation, which is followed by evaporation and cooling as the pressure falls.



Longitudinal Section of Uniflow Steam Engine Cylinder

The superior economy of the multiple-cylinder engine is due to the fact that the range of expansion is divided between two or more cylinders and the temperature difference in each cylinder is not so great as in a simple engine working to the same number of expansions. In other words the high pressure cylinder is hotter than the intermediate, and the intermediate is hotter than the low-pressure. If the whole range of expansion was effected in one cylinder its temperature would be an average between that of the live and exhaust steam.

In theory, the greater the number of cylinders, the higher the efficiency, but mechanical losses set a practical limit to the number of cylinders, four being as many as it is profitable to use. It is in this respect that the turbine is at a great advantage over the reciprocating engine. The zones of temperature can be graded by very small differences, thus reducing losses from heat interchange to a minimum. The Parsons turbine is really an expansion nozzle, hot at one end and relatively cold at the other.

Much ingenuity has been expended on steam engine design to reduce the heat losses in simple engines and make their performance approach more nearly in economy that of multiple-cylinder engines. One of the simplest and most effective cylinders is that of the so-called "uniflow" engine, patented in 1886 in Great Britain by Mr. L. J. Todd, and developed by Prof. Stumpf of Charlottenburg, Germany. This type of simple engine has recently been taken up by an American engine builder who claims that he can develop a horsepower on 24½ pounds steam non-condensing, and on 13¼ pounds condensing at 100 per cent load. At 100 per cent overload the consumption rises to 30 pounds and 14½ pounds, respectively.

The principle of the uniflow type of steam engine is that of admitting the steam at the ends of the cylinders as in all Corliss engines and exhausting at the center, thus causing no reversal of steam flow in the cylinder. The cylinder barrel is slightly more than two times the length of the stroke, the excess being in the width of the central exhaust port or ports and the clearances between the piston and cylinder heads. The increased efficiency is due partly to non-reversal of flow, the admission ends thus remaining hotter, but chiefly to reduced time of exhaust. In the common type of engine the cylinder walls are exposed to the exhaust temperature for about ninety per cent of the time required for the return stroke, whereas in the uniflow engine the exhaust period is much less.

On the return or exhaust stroke the steam remaining in the cylinder after the outer edges of the ports are passed by the piston is trapped and compressed in the clearance space to live steam pressure. This feature of the cycle, while apparently economical, is not so, thermodynamically, for the reason that the power required to compress has been generated in a comparatively low efficiency cycle and the resulting available energy in the compressed steam is far below that required for its conversion. But mechanically this feature is unavoidable for two reasons, the first being the very structure of the uniflow type, and second the need of cushioning effect in the cylinder to check the reciprocating parts and prevent shock and noise, a common requirement, of course, of all reciprocating piston engines.

* * *

RATHENAU GOLD MEDAL

The Allgemeine Elektricitäts Gesellschaft (A.E.G.) of Berlin has notified President Arthur Williams of the American Museum of Safety, New York, that the Rathenau gold medal has been placed at the disposal of the museum for award annually for the best device or process for safeguarding life and limb or promoting health in the electrical industry. The competition is open to every country in the world, the only condition being that the device or process must be exhibited at the American Museum of Safety in New York City. This is the first time that a high European honor has been given to an American institution and indicates the standing of the American Safety Museum among European scientists.

The Rathenau medal is well known in the European scientific world. It was presented to Dr. Emil Rathenau, president and founder of the Allgemeine Elektricitäts Gesellschaft, the greatest European electric company, on the occasion of his seventieth birthday, with the felicitations of the Kaiser for his services in the field of electro-technics. (He was the man who introduced incandescent lighting into Germany). One medal will now be cast each year from the original die for the American Museum of Safety to award.

* * *

THE USE OF WASTE STEAM

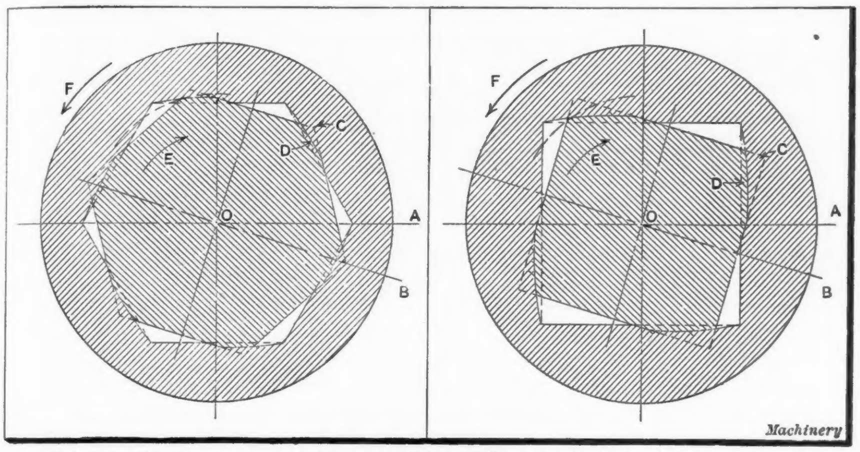
The use to which steam which formerly went to waste has been put at the Indiana Steel & Wire Co., Muncie, Ind., indicates what could be done to increase the efficiency of the steam plant in many industrial plants. In the power plant of this company two 22 by 42 inch Corliss non-condensing engines operate a series of wire-drawing benches. Each engine carries a load averaging from 370 to 400 H. P., and operates continually with the exception of Sundays and holidays. Up to two years ago electric power was purchased from an outside source to drive the machines for making wire fencing, wire nails, etc., but at that time it was decided to utilize the exhaust steam from the Corliss engines to generate this electric power. A 600 K. W. mixed-pressure Curtis turbine was installed and the exhaust steam from the two Corliss engines used to drive this turbine, which, in turn, exhausts into a condenser maintaining a vacuum of 28 inches. In case the engines are shut down, the mixed-pressure turbine automatically cuts in sufficiently high pressure steam to continue to run. The turbine now carries the entire motor load of 600 H. P., using steam that was formerly allowed to go to waste.

SQUARE VS. HEXAGON HOLLOW SET-SCREWS

ANALYSIS OF STRESSES, AND COMPARISON FOR WEAR AND STRENGTH

BY JOHN S. MYERS*

Since hollow set-screws have come into vogue, supplying a long-felt need of the manufacturer with humanitarian instincts, a controversy has arisen as to the respective merits of the square and the hexagonal form of hole, which presents an interesting problem. It is the object of this article to investigate analytically the relative claims to superiority of the two forms.



Figs. 1 and 2. Illustrations showing the Effect of Wear in the Case of a Hexagonal and a Square Wrench and Socket

Any mechanic knows that the corners of an ordinary hexagonal nut are more easily bruised and rounded off than the corners of a square nut, when using an open-ended or monkey wrench. Especially is this the case when, under dire stress of circumstances, one is compelled to use a wrench which does not fit properly, or a monkey wrench with a weak back. Nevertheless, hexagonal nuts have almost entirely superseded square ones in machine construction, for, as it seems, good and sufficient reasons. However, when we consider the case of a socket wrench, the answer to the question as to which form of nut would burr up easiest is not so apparent, for with the hexagonal nut we have six obtuse corners in action, against four square corners on the square nut; whereas, with the open-ended wrench, there are but two corners under pressure in either form. The case of the square versus the hexagonal nut, even with a socket wrench, is, however, considerably different from the case of the hollow set-screw; for, with the same size of bolt the distance across the flats of the square nut is equal to that of the hexagonal one, whereas, with the hollow set-screw, the distance across the corners is the limiting feature.

Comparison for Wear

In Fig. 1 we have a hexagonal inner member driving in the direction of arrow E against a resistance of the outer member in the direction of arrow F. It is assumed that the corners of the inner member have been worn as at C, and the faces of the outer member as at D, permitting a relative angular rotation AOB. Fig. 2 represents a square inner member with an assumed wear sufficient to permit of an angular displacement AOB, equal to the similar angle in Fig. 1. Comparing the two, it is seen that the square form would have to be worn much more than the hexagonal to permit of equal angular looseness, so that, unless the pressure on the corners of the square is sufficiently higher than that on the corners of the hexagon to offset this advantage, we would expect the square form to wear longer than the hexagonal.

Arbitrarily assuming the distance across the corners for the two forms to be equal, the depth of the two inner members to be equal, the torsional moments delivered equal, and the driving forces to be concentrated upon the extreme corners, as represented in Figs. 3 and 4, we may proceed as follows:

For the square form (Fig. 3) F acts at a lever arm

$$l = \frac{C}{2\sqrt{2}} \tag{1}$$

The turning moment of the four forces is

$$T = 4Fl = 4F\frac{C}{2\sqrt{2}}$$

$$= FC\sqrt{2}, \text{ from which}$$

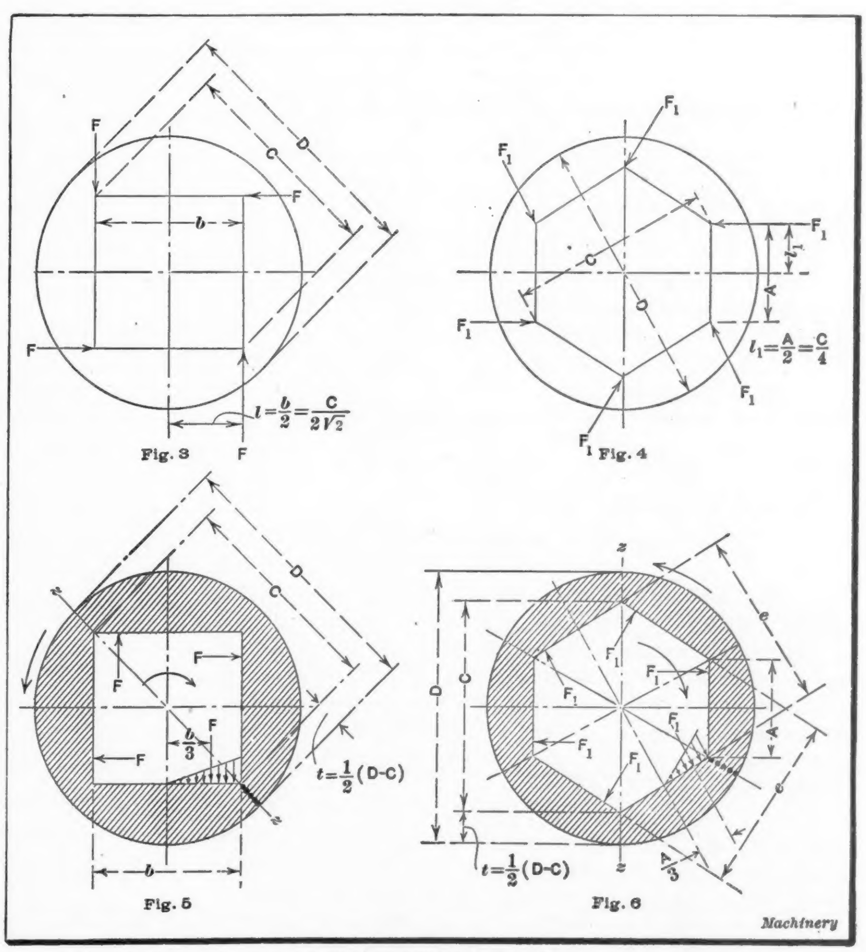
$$F = \frac{T}{C\sqrt{2}} = 0.707\frac{T}{C} \tag{2}$$

For the hexagon (Fig. 4),

$$l_1 = \frac{C}{4} \tag{3}$$

The torsional moment is $T = 6F_1l_1 = 6F_1\frac{C}{4}$, or

$$F_1 = \frac{2T}{3C} = 0.667\frac{T}{C} \tag{4}$$



Figs. 3 to 6. Diagram for Analyzing Relative Strength and Wearing Qualities of Square and Hexagon Hollow Set-screws

From (2) and (4),

$$\frac{F}{F_1} = \frac{0.707}{0.667} = 1.06. \tag{5}$$

This indicates that, under the assumed conditions, the total pressure (not the unit pressure) on the corners of the square

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is 6 per cent higher than that on the corners of the hexagon.

Comparison for Strength

Comparing the square and hexagon for torsional strength, we have the torsional section modulus of the square as:

$$Z_{ps} = \frac{C^3_s}{12} \qquad (6)$$

and for the hexagon:

$$Z_{ph} = 0.1353\, C^3_h. \quad \text{(See table.)} \qquad (7)$$

When $C_s = C_h$, the ratio of relative strengths is:

$$\frac{Z_{ph}}{Z_{ps}} = 0.1353\, C^3_h \times \frac{12}{C^3_s} = 1.62 \qquad (8)$$

or, when of equal distances across the corners the hexagon is torsionally 62 per cent stronger than the square.

If we equate $Z_{ps} = Z_{ph}$ and solve, we have:

$$C_s = 1.175\, C_h \quad (9) \qquad \text{or, } C_h = 0.851\, C_s \quad (9a)$$

which indicates that, for equal torsional strength the distance across the corner of the square form should be 1.175 times the same dimension for the hexagon, or, viewed the other way, the distance across the corners of the hexagon need only be 0.851 times the same dimension of the square.

Now, for $C_s = C_h$ we have, from (5), the total pressure on the corners of the square 1.06 times that on the hexagon, while in (8) the hexagon is shown to be torsionally 1.62 times stronger than the square; hence, if both are stressed to their full strength, the pressure on the corners of the hexagon is $\frac{1.62}{1.06} = 1.53$ times the similar pressure on the square (10).

In the case of the hollow set-screw, however, the outer member is of equal (if not of greater) importance than the inner member. The ideal condition would be to have both members of equal strength. Investigating in this direction, we have for the torsional section modulus of a circular section with a square hole (Case V in table):

$$Z_p = \frac{\pi D^3}{16} - \frac{b^4}{3D}. \qquad (11)$$

For the square inner member (Case II in table):

$$Z_p = \frac{b^3}{3\sqrt{2}}. \qquad (12)$$

Equating these, we have:

$$\frac{b^3}{3\sqrt{2}} = \frac{\pi D^3}{16} - \frac{b^4}{3D}. \qquad (13)$$

Now let $b = xD$; then:

$$\frac{x^3 D^3}{3\sqrt{2}} = \frac{\pi D^3}{16} - \frac{x^4 D^4}{3D}, \text{ or } \frac{x^3}{\sqrt{2}} + x^4 = \frac{3}{16}\pi \qquad (14)$$

From (14) we have $x = 0.74$, or $b = 0.74D$. (15)

But $b = \frac{C}{\sqrt{2}}$, hence:

$$\frac{C}{\sqrt{2}} = 0.74D \text{ or } C = 1.046D. \qquad (16)$$

The significance of Equation (16) is that it is impossible to make a square inner member of torsional strength equal to the round outer member, because the distance across the corners of the square becomes greater than the diameter of the outer member thus splitting it up into four separate sections.

Treating the hexagonal form in a similar manner it is found that, for the inner and outer members to be of equal strength, we would have:

$$C = 0.912D \qquad (17)$$

Just how thin the metal over the corners might be made without destroying the continuity of the section, and thus entirely upsetting the conditions upon which the theory of torsion is based, is problematic. It would, however, seem impracticable to give C as large a value as indicated by (17).

Proportion of the Inner to the Outer Member and their Relative Strengths—The Square Form

The problem now resolves itself into one of how large the inner member may be made without danger of rupture in the outer member at the corners. Referring to Fig. 5, the pressure against the sides of the square is maximum at the advancing corner and may be assumed to diminish uniformly to zero at the center of the side. The center of pressure on each face is then at F, at a distance of 1/3 b from the center, and the torsional moment of the four forces is:

$$T = \frac{4Fb}{3}. \qquad (18)$$

Taking the depth of the square hole as equal to b, the area of material resisting rupture at the corner, as at z, is:

$$a = tb = \frac{D-C}{2}\, b, \text{ and, since } C = b\sqrt{2},\ a = \frac{D - b\sqrt{2}}{2}\, b \qquad (19)$$

With a unit stress of S this area is capable of resisting a force of:

$$F_s = a\,S = \frac{D - b\sqrt{2}}{2}\, b\,S \qquad (20)$$

Now, for simplicity of treatment as well as safety, we will consider the entire force F in Fig. 5 as concentrated upon this area a. We then have $F = F_s$, and, by substituting the value of F_s as given by (20) for F in (18) we have:

$$T = \frac{4b}{3}\left(\frac{D - b\sqrt{2}}{2}\right) b\,S = \frac{2}{3}\, b^2 S\,(D - b\sqrt{2}) \qquad (21)$$

This equation represents the extreme torque of the outer member without causing rupture at the corners.

The torsional strength of the inner member is:

$$T = Z_p\, S = \frac{S\,b^3}{3\sqrt{2}} \qquad (22)$$

Equating (21) and (22) we have:

$$\frac{2}{3}\, b^2 S\,(D - b\sqrt{2}) = \frac{S\,b^3}{3\sqrt{2}}$$

from which

$$b = \frac{2\sqrt{2}}{5}\, D = 0.566\, D \qquad (23)$$

$$\text{or } C = 0.800\, D \qquad (23a)$$

Equations (23) and (23a) represent the largest size of square inner member that can be used without danger of rupture of the outer member at the corners.

Substituting the value of b as given by (23) in (12) we have:

$$Z_p = \left(\frac{2\sqrt{2}}{5}\, D\right)^3 \div 3\sqrt{2} = \frac{16}{375}\, D^3 = 0.0427\, D^3 \qquad (24)$$

which is a measure of the torsional strength of the square form of the inner member.

If we divide the result of Equation (24) by the torsional section modulus of a solid circular section (Case I in table) we have:

$$\frac{16D^3}{375} \times \frac{16}{\pi D^3} = 0.2173. \qquad (25)$$

This indicates that a square inner member may approximate 22 per cent of the torsional strength of a solid circular section of a diameter equal to that of the outer member.

Proportion of the Inner to the Outer Member and their Relative Strengths—The Hexagonal Form

Investigating the case of the hexagonal form of inner member in a similar manner (see Fig. 6), we have first that the torsional moment of the six forces F_1 is:

$$T = 6F_1 \frac{A}{3} = 2F_1 A. \qquad (26)$$

Assuming the depth of hole to equal e, the area resisting F_1 is $a = e\,\frac{D-C}{2}$, and since $e = A\sqrt{3}$,

$$a = A\sqrt{3}\,\frac{D-C}{2} \qquad (27)$$

The force that this area is able to resist is:

$$F_1 = a\,S = \frac{\sqrt{3}}{2}\, A\,S\,(D - C), \text{ or, since } C = 2A$$

$$F_1 = \frac{\sqrt{3}}{2} A S (D - 2A) \qquad (28)$$

Substituting this value of F_1 in (26) we have:

$$T = \sqrt{3}\, A^2 S (D - 2A) \qquad (29)$$

The torsional strength of a hexagon (see Case III in table) is:

$$T = Z_p S = \tfrac{5}{8}\sqrt{3}\, A^3 S \qquad (30)$$

Equating (29) and (30), and reducing gives us:

$$A = \tfrac{8}{21} D = 0.381\, D \qquad (31)$$

From (31) we have $C = 0.762\, D$ (31a); or $e = 0.66\, D$ (31b). Equations (31), (31a) and (31b) represent the various dimensions of the largest size of hexagon that can be used without danger of rupture of the outer member at the corners.

The torsional section modulus of a hexagon (Case III in table) is:

$$Z_p = \tfrac{5}{8}\sqrt{3}\, A^3 \qquad (32)$$

Substituting the value of A from (31) in (32) gives:

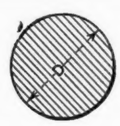
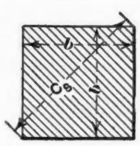
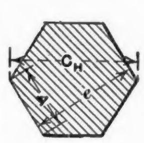
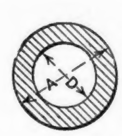
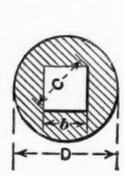
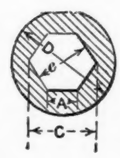
$$Z_p = \tfrac{5}{8}\sqrt{3}\, (\tfrac{8}{21} D)^3 = 0.0598\, D^3 \qquad (33)$$

Equation (33) is the measure of the torsional strength of the hexagonal form of inner member. If we divide this by the torsional section modulus of a solid circular section, as given in Case I of the table, we have:

$$0.0598 D^3 \times \frac{16}{\pi D^3} = 0.3048 \qquad (34)$$

which indicates that the hexagonal inner member may develop approximately 30 per cent of the strength of a solid circular section of a diameter equal to the outer member, as against 22 per cent for the square form of inner member. Stated in another way, the hexagonal form is $0.3048 \div 0.2173 = 1.4$, or 40 per cent stronger than the square form for equal sizes of the outer member.

PROPERTIES OF SECTIONS

Case	Section	Polar Moment of Inertia I_p	Polar Section Modulus Z_p	Remarks
I		$I_p = \frac{\pi D^4}{32} = 0.098\, D^4$	$Z_p = \frac{\pi D^3}{16} = 0.196\, D^3$	
II		$I_p = \frac{b^4}{6} = 0.1667\, b^4$	$Z_p = \frac{b^3}{3\sqrt{2}} = 0.236\, b^2 = \frac{C^3_s}{12}$	Taking Case II as an inner member for Case V and making $b = 0.566\, D$, the inner member would be the weakest and the section modulus for II is $Z_p = 0.043\, D^3$
III		$I_p = \frac{5\sqrt{3}}{8} A^4 = 1.0825\, A^4$	$Z_p = \frac{5}{8}\sqrt{3}\, A^3 = 1.0825\, A^3$ $= \frac{5\sqrt{3}}{64} C^3_h = 0.1353\, C^3_h$ $= \frac{5}{24} e^3 = 0.2083\, e^3$	Taking Case III as an inner member for Case VI and making $e = 0.66\, D$, the section modulus for III is $Z_p = 0.06\, D^3$
IV		$I_p = \frac{\pi}{32}(A^4 - D^4)$ $= 0.098\,(A^4 - D^4)$	$Z_p = \frac{\pi}{16}\left(\frac{A^4 - D^4}{A}\right)$ $= 0.196\left(\frac{A^4 - D^4}{A}\right)$	If the inner section of diameter D is to be of a torsional strength equal to the outer hollow member, make $D = 0.82\, A$ or $A = 1.22\, D$
V		$I_p = \frac{\pi D^4}{32} - \frac{b^4}{6}$ $= 0.098\, D^4 - 0.167\, b^4$	$Z_p = \frac{\pi D^3}{16} - \frac{b^4}{3D}$ $= 0.196\, D^3 - 0.333\, \frac{b^4}{D}$ With an inner member the largest probable safe value of b is $b = 0.566\, D$, from which $C = 0.8\, D$	If the inner section were to be of strength equal to the outer section it would be necessary to make $b = 0.74\, D$ or $C = 1.046\, D$, which is impossible, since C would be greater than D
VI		$I_p = \frac{\pi D^4}{32} - \frac{5\sqrt{3}}{8} A^4$ $= 0.098\, D^4 - 1.0825\, A^4$	$Z_p = \frac{\pi D^3}{16} - \frac{5\sqrt{3}\, A^4}{4D}$ $= 0.196\, D^3 - 2.165\, \frac{A^4}{D}$ With an inner member the largest probable safe value of e is $e = 0.66\, D$, from which $C = 0.762\, D$	If the inner section were to be of strength equal to the outer section, make $A = 0.456\, D$ or $C = 0.912\, D$. This leaves the material very thin at the corners.

Unit Pressure on Driving Faces—The Square Form

Considering the pressure to be distributed as indicated in Fig. 5, with the depth of the inner member equal to b, we have the unit bearing pressure on the driving faces at the corners of the square as

$$P_s = \frac{F}{b \times \frac{1}{2} b} \times 2 = \frac{4F}{b^2} \qquad (35)$$

From (18) we have $F = \frac{3T}{4b}$. (18a)

Substituting this value of F in (35) gives us:

$$P_s = \frac{4}{b^2} \times \frac{3T}{4b} = \frac{3T}{b^3} \qquad (36)$$

Now substituting in (36) the value of b as given by (23) we have:

$$P_s = 3T\left(\frac{5}{2\sqrt{2}D}\right)^3 = 16.573\frac{T}{D^3} \qquad (37)$$

In (24) we have the section modulus of the square member, which, multiplied by the stress S, gives:

$$T = 0.0427\, D^3 S \qquad (38)$$

Substituting this value of T in (37) we have:

$$P_s = \frac{16.573}{D^3} \times 0.0427\, D^3 S = 0.708\, S \qquad (39)$$

Equation (39) gives the unit bearing pressure on the corners as about 71 per cent of the torsional stress in the inner member, which is a very safe bearing value, and indicates that the inner member would fail by twisting rather than by crushing at the corners.

Unit Pressure on Driving Faces—The Hexagonal Form

Treating the hexagonal form of Fig. 6 in a similar manner, with depth of inner member equal to e, we have for the unit bearing pressure at the corners:

$$P_h = \frac{F_1}{e \times \frac{1}{2}A} \times 2 = \frac{4F_1}{eA} \qquad (40)$$

Now $e = A\sqrt{3}$, and, from (26), $F_1 = \frac{T}{2A}$; then:

$$P_h = \frac{4T}{2A \times A\sqrt{3}A} = \frac{2\sqrt{3}}{3}\frac{T}{A^3} \qquad (41)$$

From (31), $A = \frac{8}{21}D$, then:

$$P_h = T\frac{2\sqrt{3}}{3} \times \left(\frac{21}{8D}\right)^3 = 20.886\frac{T}{D^3} \qquad (42)$$

From Equation (33) we have, for the strength of the hexagon:

$$T = 0.0598 D^3 S \qquad (43)$$

Substituting this in (42) gives us:

$$P_h = \frac{20.886}{D^3} \times 0.0598\, D^3 S = 1.249\, S \qquad (44)$$

Equation (44) gives the unit bearing pressure at the corners as about 25 per cent higher than the torsional stress in the inner member, which is about in the same relation as the ultimate tensile and shearing strength, so that this bearing pressure is not too high.

When both forms are developing their full respective strengths we have, from (44) and (39), the ratio

$$\frac{P_h}{P_s} = \frac{1.249}{0.708} = 1.76 \qquad (45)$$

or, under this condition, the unit pressure on the corners of the hexagon is about 76 per cent higher than on the corners of the square; so that, if tested to destruction, we would expect the corners of the inner member and the internal faces of the outer member to be much more distorted in the case of the hexagon than in the case of the square.

When both outer members are of equal size and transmit equal torques, we have from (42) and (37) the ratio

$$\frac{P_h}{P_s} = \frac{20.886\,T}{D^3} \times \frac{D^3}{16.573\,T} = 1.26 \qquad (46)$$

or, under this condition, the unit pressure on the corners of the hexagon is about 26 per cent greater than that on the corners of the square.

Conclusions—Comparison of the Two Forms of Set-screws

1.—With the distance across corners equal and the depth of inner members equal for the two forms:

a.—The hexagonal form is torsionally 62 per cent stronger than the square. See Equation (8).

b.—Under the same conditions, and considering the total driving forces as concentrated at the extreme corners,* this force is 6 per cent higher for the square than for the hexagon, if delivering equal torques. See Equation (5).

2.—For equal torsional strength the distance across the corners of the square should be 1.175 times the similar dimension for the hexagon. See Equations (9) and (9a).

3.—It is impossible to have the inner member of torsional strength equal to the outer member, because the outer member would rupture at the corners. This impossible but desirable condition is more nearly attained with the hexagon than with the square. See Equations (16) and (17).

4.—With the depth of hole equal to the distance across the flats of the inner member:

a.—We may, for the square form, make $b = 0.566D$, or $C = 0.8D$. See Equations (23) and (23a).

b.—For the hexagonal forms we may make $e = 0.66D$ or $C = 0.762D$. See Equations (31a) and (31b).

c.—These proportions will prevent rupture at the corners when the full torsional strength is developed.

d.—When so proportioned the square member develops 22 per cent and the hexagonal member 30 per cent of the strength of a solid circular member of diameter D. See Equations (25) and (34).

e.—The hexagonal form is thus 40 per cent stronger than the square form for equal sizes of the outer member.

f.—The unit bearing pressure on the driving faces is 71 per cent of the unit torsional stress for the square, and 125 per cent of the unit torsional stress for the hexagon. See Equations (39) and (44).

g.—When subjected to equal torques, with equal sizes of outer member, the unit bearing pressure on the driving faces is 26 per cent higher for the hexagonal than for the square form. See Equation (46).

5.—The hexagonal form is thus shown to be superior for strength, or for equal strength to be smaller, hence more compact.

6.—The square form is superior in wearing qualities because of less unit bearing pressure on the driving faces.

7.—Hence, the proper field for the hexagonal form is for parts not requiring much adjustment, such as set-screws in collars, wheel-hubs, etc., while the field for the square form is in parts requiring frequent adjustment, such as the screws in lathe and drill chucks. Use the hexagonal form for compactness and strength; the square form for wearing qualities.

* This is an arbitrary assumption. The writer believes the distribution of forces to be more nearly as shown in Figs. 5 and 6.

* * *

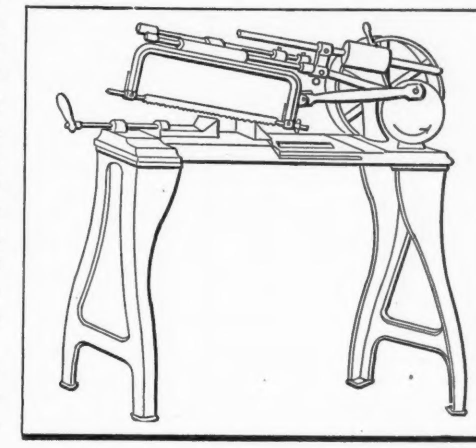
TESTING STEEL FOR AUTOMOBILE PARTS

The careful tests to which the products of the G. Derihon Co. of Liege, Belgium, are put, explain the high standard which this firm has reached in the manufacture of automobile parts subjected to high stresses and shock. Since 1904 this firm has employed the Fremont drop test, and the results obtained have been very satisfactory. At the Derihon shops a test piece is taken from every piece out of which an automobile part is forged, and this test piece is forwarded to the customer together with the part ordered and a record of the results of the test. Thus, when sending out an order of twenty-eight steering levers, the company accompanies it with a list of twenty-eight tests. This increases the cost per lever by approximately five cents, but it gives an absolute certainty that the piece will stand as much as it is expected to. This policy makes it necessary for the firm to test from ten thousand to twelve thousand pieces per month, and on account of the experience thus obtained, it is interesting to note some of the conclusions arrived at by this firm with relation to the method of making these tests. For the drop test the firm uses test specimens 10 by 8 millimeters (25/64 by 5/16 inch, approximately) with a one-millimeter nick (3/64 inch approximately). If test pieces of larger dimensions are used, they are not likely to reveal minor defects. While brittleness in steel is often a local condition, it would be none the less objectionable and dangerous in the completed machine detail. As an indication of what can be accomplished by a commercial shop testing department and by taking advantage of the knowledge obtained from the tests made, it may be mentioned that at the outset the Derihon firm had to reject, for brittleness, from 20 to 40 per cent of the pieces tested, whereas during 1911 the total number of rejected parts averaged 0.3 per cent. This result has been obtained entirely from the fact that the testing of the steel has enabled the firm to apply proper heat-treatment to its steel products. In the opinion of M. Derihon it is possible to make all steels of good quality non-brittle. The whole question is simply one of heat-treatment, different steels, of course, requiring entirely different treatment in order that satisfactory results may be obtained.

RECIPROCATING STRAIGHT-BLADE SAWING MACHINES*

DEVELOPMENT OF HACKSAW MACHINES, WITH SPECIAL REFERENCE TO BRITISH PRACTICE

The material presented in the following has been gathered with the idea of setting forth the merits of the straight-blade reciprocating saw for metal work, as compared with those of the band saw and the circular saw. The latter types have been developed to approximately the same degree of efficiency which has been attained in other types of machine tools, while many reciprocating saws remain in essentially the condition in which they were first placed upon the market. The author believes that the Millers Falls Co. placed the first hacksawing machine upon the market. This machine is shown in Fig. 1, from which it will appear that its design is of a character hardly suitable to modern shop conditions. Fig. 2 shows the next hacksaw machine that was introduced. This is a more elaborate and heavier type than the preceding, and the old hacksaw frame has given way to a stronger design.



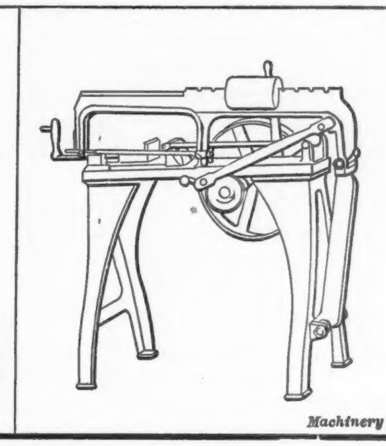
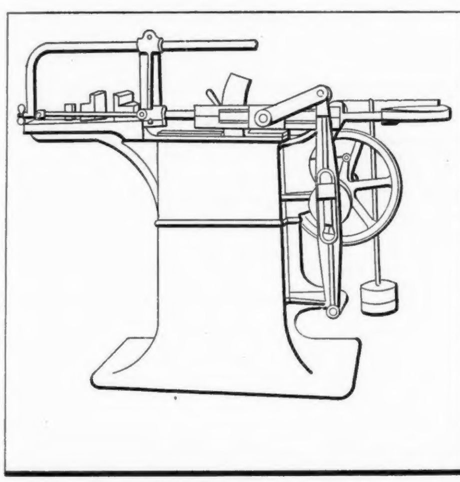


Fig. 1. The Star, the First Type of Hacksaw Machine. Fig. 2. The Simplex, another Early Type

Another very early pattern of hacksaw was the Eureka, shown in Fig. 3. This machine was made by G. Thompson, Son & Co. It is designed along far better lines than the preceding types, having a solid base and provision for guiding the saws. The thrust is in a direct line, and the upper guide is made to extend in such a way that it admits of a large variation in the length of blade used. The long blade, similar to a band saw, is coiled up and brought out for use as the working part becomes worn. This coil contains about twenty-five feet.



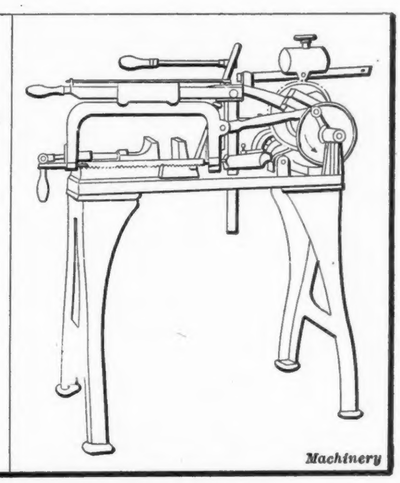


Fig. 3. The Eureka Hacksaw Machine. Fig. 4. The Milford Machine, an Improved Type

The Milford saw, shown in Fig. 4, is a still more carefully designed tool. It is fitted with a quick return and a clutch device for lifting the blade free of the work on the idle or return stroke. It has a gear drive of 4 to 1 and an automatic stop. In the author's opinion, these four designs are a fair illustration of the progress of the original type of hacksawing machine up to a recent date.

Messrs. Herberts of Manchester, England, were the first firm who seriously took up the matter of improving the design of hacksaw machines. The object was to make a stronger machine which would be capable of working more rapidly and of taking larger sections. They have made saws of a capacity hitherto commercially unknown, the largest being capable of taking 18 by 30 inches. Among other improvements they introduced an automatic feed for the work, and an eccentric motion was given to the fulcrum of the saw frame, as shown in Fig. 5. This made it possible for the fulcrum of the saw frame to be moved around slightly at intervals of 20 strokes, thus putting the saw at a different angle to the work. In this way it was working on a comparatively small surface at all times and was thus capable of handling larger sections. Such saws were capable of cutting a 4-inch bar in twenty minutes, as compared with an hour taken by the earlier types of machines. The only disadvantage of this method lay in the strain placed upon the saw blade after each move of the eccentric. The author believes that his firm was the first to use a stronger and better blade, and they were aided in this by the Sterling Co., who used tungsten steel.

Messrs. Holroyd & Co., of Milnrow, England, also introduced an excellent machine for rapid work with the same object in view that Messrs. Herberts had. In the Holroyd machine the bar was slightly turned around at intervals of several strokes instead of altering the angle of the saw. The advantage of this system lay in the fact that as the bar was continually turning around, it was difficult for the saw to run out, and the work would be approximately as true as that produced in a cutting-off lathe.

Advantages of Hacksaw Machines

The advantages of hacksaw machines as compared with other types are briefly as follows: First, the cost of the machine and blades, is comparatively low and the blades can be brought to any temper to suit the work. Second, a hacksaw will cut to any depth that the frame which holds it will permit; extra depth does not necessitate extra cost of blades as in the case of the circular saw, where the bosses limit the depth of cut to approximately 1/3 the diameter of the saw. It may also be mentioned in this connection that a circular saw is necessarily fairly thick and exceedingly difficult to get quite hard. Circular saws are also liable to break if hardened beyond certain limits. Third, in the case of band saws it is frequently necessary to cut the blade in order to thread it through the work, and, like the circular saws, it is almost impossible to get them quite hard. Fourth, another advantage of the straight blade over the circular saw or lathe cutting-off machine lies in the narrowness of the cut, say 1/16 inch instead of ¼ inch.

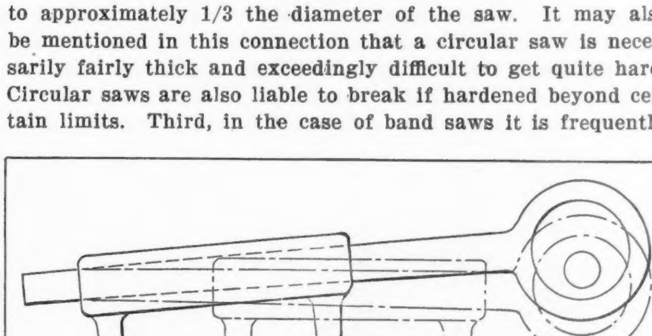


Fig. 5. Eccentric for tilting the Saw

* Abstract of a paper by Mr. Charles Wicksteed read before the Belfast meeting of the Institution of Mechanical Engineers, July, 1912.

This difference in the width of cut makes a great saving possible when working on such expensive materials as high-speed steel. Fifth, the power taken by a hacksaw is about one-fourth of that taken by a circular saw.

When once convinced that the straight-blade sawing machines had as great advantages as their competitors, it did not take long to discover the principles on which the blades must be made and operated. These may be briefly outlined as follows:

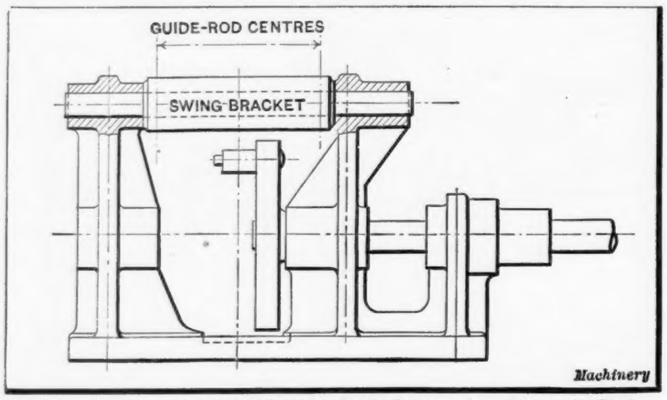


Fig. 6. Arrangement of Bearings for Guide Frame, viewed from the Back

First, the blade must be kept absolutely firm and perfectly square with the work. Second, it must be strong enough to stand all the weight that the teeth will take without breaking. Third, the blade must be made of the highest possible quality of steel with the best cutting edge that is practicable. Fourth, the machine must be well designed and work without

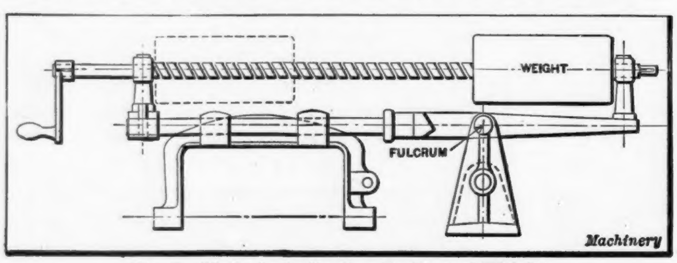


Fig. 7. Method of adjusting Position of Weight

spring or vibration. Fifth, since the pressure on the blade must be considerable, a reliable release on the return stroke must be provided. However, the results of experiments by the author have shown that unless the weight was heavy it made little difference whether the blade was released on the return stroke or not, but where a heavy weight is used, the blade will be quickly destroyed unless this precaution is observed.

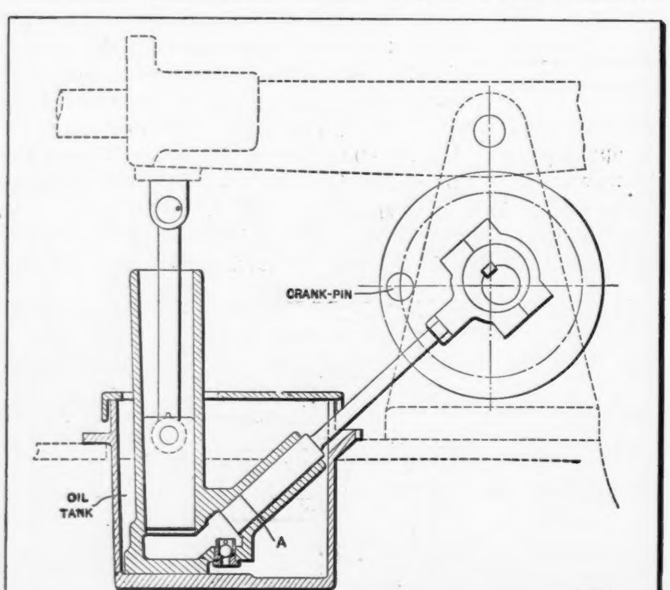


Fig. 8. Pump and Ram used to lift and lower the Saw at End of Stroke

Taking the points just mentioned into consideration, it will be evident that the blades have not been developed to this high standard without the expenditure of a great deal of effort on the part of the manufacturers. These improvements may be briefly outlined as follows: First, for ordinary work, a coarse pitch tooth, not less than 10 to the inch, has been found most suitable. Such teeth cut better, clear themselves better, and give a better opportunity for side clearance which is especially necessary in the deep blades used on heavy machines. Second, to make the teeth strong enough to take all the weight that they will stand, it is not necessary to do any special tempering. If the teeth are properly hardened, the back of the blades will also be of the proper hardness. Third, additional strength must be obtained by increasing the depth and not the thickness of the blade. An increase in thickness means a corresponding increase in the amount of power required to drive the machine. Theoretically, the thinner the blade can be made the better. This is limited, however, by difficulty experienced in hardening deep thin blades in such a way that they are absolutely straight. Deep blades are also more difficult to work and still keep the proper clearance. The blades used by the author vary from ¾ inch to 2 inches in depth and from No. 19 to No. 16 wire-gage in thickness. Fourth, the greatest weight that a tooth will take without injury must be ascertained and the blades then made strong enough to carry it. A weight of 210 pounds is about right for a 6-inch machine, and enables the machine to use practically the full capacity of the blade up to a 4-inch round bar. As the machines become larger, the proportion of weight is increased. Thus a 15-inch machine requires 700 pounds on the saw to get the full capacity of the blade when working on a 10-inch surface.

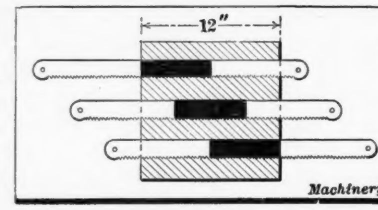


Fig. 9. Diagram showing how Saw is freed of Swarth

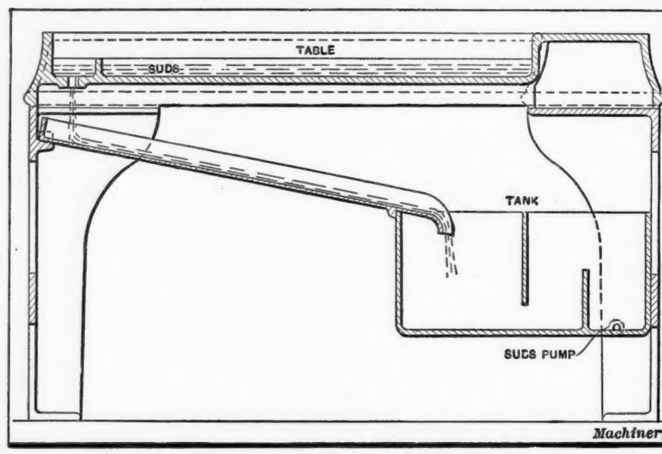


Fig. 10. Arrangement of Tank and Pump Connections

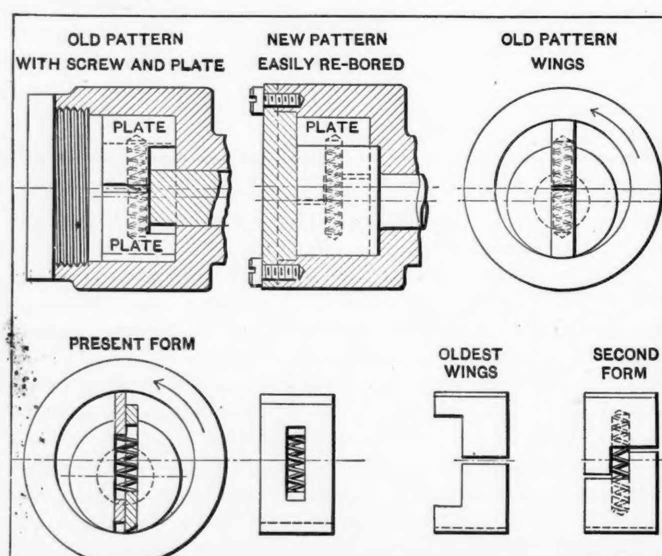


Fig. 11. The Type of Lubrication Pump used

Design of Machines

After having said this much about blades, it is hardly necessary to point out that corresponding improvements were required in the machines that drive them.

One of the greatest faults in early types of hacksaws is found

in the fact that the guide frame was almost universally pivoted on the crankshaft. Narrow bearings were usually employed, thus giving some play to begin with, which was constantly increased by wear. Hence the design lacked the first essential of a good machine. The loose guide allowed the saw to run out, to produce bad work, and to break the blades. To avoid these fundamental defects, the author applied a guide frame which is pivoted on independent bearings of the type shown in Fig. 6. These bearings have no other work to do than to guide the frame, and there is practically no wear. The machine is of rigid construction and the bed is of sufficient width to provide a bearing for the bar on both sides of the saw. The guide bars are placed far apart and all bearings are of ample proportions and bronze-bushed. The weights have been correspondingly increased so that a 6-inch machine weighs 550 pounds and

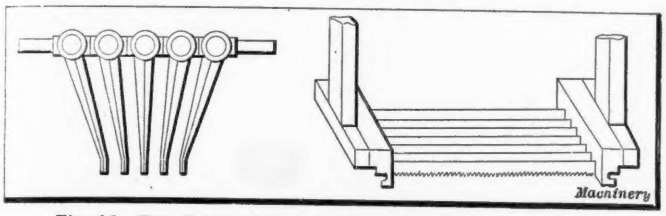


Fig. 12. Two Styles of Saw Racks used on Multiple Machines

a 15-inch machine 2500 pounds. Such weights are necessary to make the machine perfectly firm and free from vibration.

The additional weight used on the blade made it necessary to adopt a convenient method of varying it according to the requirements of the work. This is done by means of a sliding weight on a bar which runs from the extreme end of the frame to a point well behind the fulcrum of the spring bracket. In the heavy machines this weight is adjusted by a quick pitch screw, the arrangement being shown in Fig. 7. Having such a heavy weight to deal with, it was next necessary to provide means to protect the machine from breakage in case the blade should break. A reliable release was also required on the return stroke of the blade. The latter is a difficult thing to provide for by purely mechanical means, as the plane of the saw varies at every stroke; but experiments have shown that it is essential for the saw to be lifted off the work at the end of the cutting stroke and put down again accurately at the end of the return stroke. If this is not done the output will either be seriously interfered with or the blade will be injured.

Fig. 8 shows the device by which the release of the saw is obtained. It will be seen that an eccentric set in time with the crank-pin on the crankshaft works a plunger in connection with the dash-pot. This plunger comes down and closes the port *A* at exactly the end of the stroke, thus gently lifting the frame sufficiently off the work during the return stroke and letting it down again as soon as the working stroke begins. There are no complications and no wear in this device, as both pistons are simply made a good fit and worked in oil. A foot-valve is provided to let the oil in when the frame is lifted by hand.

Later modifications of this device have been made to make it useful for other purposes. The port is made small enough to convert the larger cylinder into a dash-pot, thus making it impossible for the frame to fall, as it can only be lowered as fast as the oil is pressed through the small port *A*. This port is about 1/32 inch in diameter in the case of the small machines.

The stroke of the author's machine is from 5 to 8 inches. The longer stroke adopted in the larger machines was not found necessary to get rid of the swarth, but simply because it was found advisable to reduce the strokes as the length of the frames was increased. The question of the relative length of the blade to the stroke and the diameter of the bar is interesting. A long stroke should be avoided, as it entails a correspondingly long blade as well as a more cumbersome machine. If there is no lift on the return stroke, the stroke must be made as long as the section being cut, to get rid of the swarth.

Fig. 9 shows a 12-inch section being cut with a machine operating on a 6-inch stroke. In this diagram the middle part of the blade is shown black. This section has no opportunity of getting rid of its swarth, and will therefore, if not lifted, take the greatest part of it backward and forward. With sufficient lift on the return stroke, however, the swarth is dropped and raked 6 inches forward on the cutting stroke. Consequently it is only necessary to make the teeth deep and large enough to hold the swarth gathered during two strokes.

The lubricant used for saw blades is soap-suds, and great attention has been paid to the pump and tank used for lubricating purposes. The fact that the swarth made by the saws is exceedingly fine, and that it is much more difficult to operate a pump properly with suds than with oil, necessitated a careful provision to keep the swarth away from the pump. Fig. 10 shows the arrangement of the tank and connection, where it will be seen that the suds are first collected by a recess in the bed and then drained at the front end, which is farthest away from the point where the swarth is dropped. The suds then run through a trough to a tank at the back end of the machine. This tank is divided by two weirs, the lubricant going under the first weir and over the second. In this way any light swarth floating on the surface of the fluid is stopped.

Type of Pump Used

Wing pumps were decided upon as most satisfactory for this service, but the best type available was of such construction that it would not wear well. The simple type of pump shown in Fig. 11 was finally adopted. In this type a by-pass is provided, not with a separate valve, but simply by making the wings of the pump taper against the pressure, so that when a full discharge is not required the increased pressure of the suds presses the wings inward. The cover is fastened by screws instead of being secured by a thread in the end of the cylinder, this design making it easy to rebore when necessary. The wings are provided with two small slots of such a length that one spring put in the middle will press up the wings on each

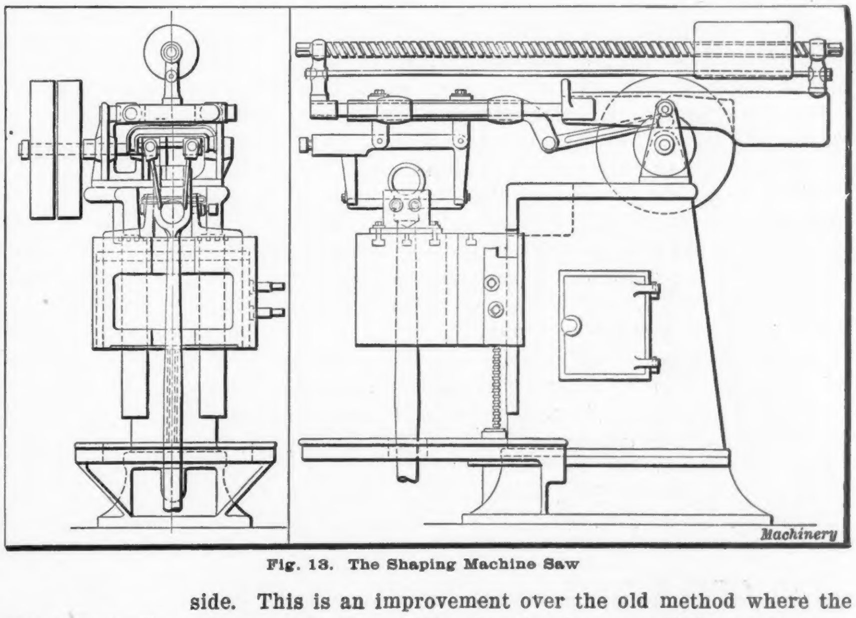


Fig. 13. The Shaping Machine Saw

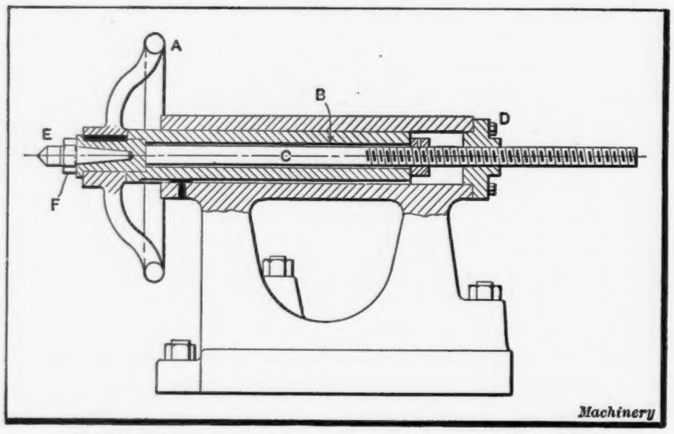
side. This is an improvement over the old method where the wings met in the middle, thus leaving very little bearing surface. The gradual wearing of this bearing caused friction which led to the destruction of the pump.

The result of these improvements is that sawing can be done practically true, say to 0.010 inch in cutting a 6-inch bar, and mild steel can be cut at a speed of approximately 1 to 2 inches per minute. The breakage of the blades is also rare. In conclusion, the author states that his purpose in presenting this review is merely to trace the development of a most useful tool, so far as it has gone. He is of the opinion that nothing like perfection has yet been approached, and believes that in rapidity of work, endurance of blades, and in the size of machines, the reciprocating straight-blade sawing machine has many advantages sufficient to warrant making its improvement a matter of careful study.

IMPROVED LARGE LATHE TAILSTOCK

A new form of tailstock for large lathes designed to facilitate adjustment when centering heavy and awkward parts, was recently illustrated in the *Practical Engineer*. The common position of the handwheel on the outer end of the tail spindle is so far from the center point on large lathes that the machinist can reach it with difficulty when watching the center enter the work. On very large forge lathes the adjusting handwheel is sometimes placed on the side of the tailstock, near the inner end of the spindle and is connected to the screw by a shaft and bevel and spur gears to overcome the difficulty. This construction is objectionable, of course, for medium size lathes on the score of cost.

In the new design the handwheel *A* is placed on the inner end of the tailstock where it is mounted on the screw *C*. The center *E* is set in the end of the screw, the screw being made



Tailstock for Heavy Lathes having Handwheel on Inner End

with an enlarged end for the socket. The screw is supported by the quill *B* and is threaded in the nut *D*. A nut *F* is provided on the center for ejecting it as the construction does not permit the self-discharging principle of the common form of tailstock to be used.

The contributor of the design points out that it is not well adapted to small lathes because of the interference of the handwheel with the compound rest. By giving the handwheel considerable dish, however, and overhanging the nose of the tailstock this defect might be overcome. The projection of the screw is another objectionable feature which might be avoided by slightly changing the design so that the parts would telescope, the nut being made in the form of a tube with the thread at the end. This construction would necessarily make the quill somewhat larger relatively than shown in the illustration, but would materially reduce the overall length and improve the appearance.

An objection to the design not mentioned by the contributor, of little importance, perhaps on heavy lathes, but of some weight in the design of small lathes, and especially toolroom lathes, is that the tail center is mounted in a revolving part and cannot, therefore, be considered a dead center. Eccentricity of the center point would cause trouble by throwing the centers out of line.

* * *

FATIGUE STRESSES IN MACHINE STEEL

In a paper on "Endurance Tests of Machine Steel," presented before the International Association for Testing Materials, New York, September, 1912, Mr. J. O. Roos of Hjelmsäter calls attention to the so-called "fatigue ruptures" which occur in parts which are subjected to continually repeated shocks or stresses of small magnitude. Machine parts which are subjected to continual stresses in varying directions, or to repeated shocks even though of comparatively small magnitude, can hardly be satisfactorily designed (nor can the material be chosen) from a mere knowledge of the behavior of the material under a steady stress, such as imposed upon it by ordinary tensile stress testing machines. From the numerous cases of machine parts broken under actual working conditions, and which Mr. Roos had had occasion to examine in the course of his work, the most tangible and positive result obtained was that at least 80 per cent of these ruptures had been caused by fatigue stresses, the surface of the fracture showing the characteristic crack for this kind of a break. Among the pieces of this kind examined were railway car axles, parts of steam engines, and parts from motor cars and trucks. Most fatigue ruptures in practice are caused by bending stresses, and very frequently by a revolving bending stress. Hence, to test materials for this class of stress, the tests should be made to stress the material in a manner similar to that in which it will be stressed while under actual working conditions. This can be accomplished by subjecting a projecting test piece held at one end to a load at the other end, and revolving the test piece while subjected to the load. A machine for carrying out tests of this kind has been developed in the United States by Mr. Henry Souther of Hartford, Conn.

* * *

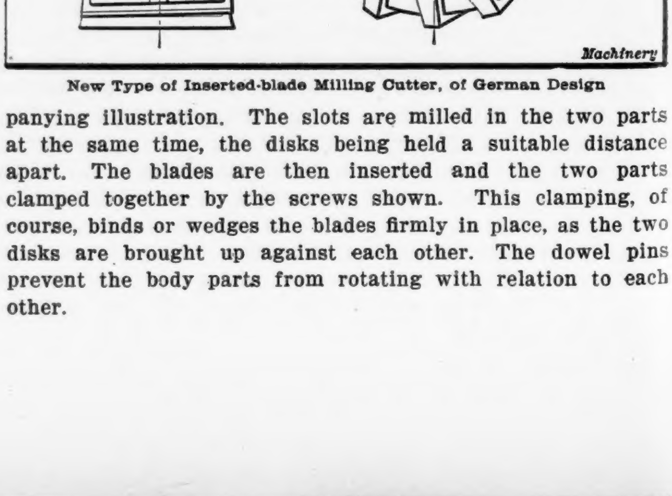
THE NITROGEN INDUSTRY IN NORWAY

One of the interesting features of the eighth international congress of applied chemistry, held in New York during the early part of September, was a lecture delivered by Dr. Samuel Eyde of Christiania, Norway, in which he described the development of the nitrogen plants that have recently been built in Norway, and in the development of which he has played a leading part. Lantern slides were shown of four great nitrogen plants under Dr. Eyde's control, having a total capacity of 200,000 horsepower and producing yearly 80,000 tons of nitrate of lime for fertilizing purposes, 10,000 tons of nitrate of ammonia for use in explosives, and 10,000 tons of nitrate of soda for use in coloring industries. It is very interesting to note how a country so poor in regard to natural resources as is Norway, except for the enormous power represented by the water falls, has in this way been able to develop an industry requiring practically no other raw materials than air and water. It has been predicted that chemical industries in which electricity plays an important part will, in the future, be largely concentrated in the Scandinavian countries because of their available water power, and hence their cheap supply of electric energy. As Norway, especially, is a country which is not suited for agriculture, the development of these industries is a highly important factor in its prosperity.

* * *

NEW TYPE OF INSERTED-BLADE MILLING CUTTER

The accompanying illustration shows a new development in inserted-blade milling cutters, patented by the Sächsischen Maschinenfabrik in Chemnitz, Germany. The body of this inserted-blade cutter consists of two disk-shaped parts, held together by screws and dowel pins, as indicated in the accompanying illustration.



New Type of Inserted-blade Milling Cutter, of German Design

The slots are milled in the two parts at the same time, the disks being held a suitable distance apart. The blades are then inserted and the two parts clamped together by the screws shown. This clamping, of course, binds or wedges the blades firmly in place, as the two disks are brought up against each other. The dowel pins prevent the body parts from rotating with relation to each other.

SCIENTIFICALLY MANAGED PRESS WORK

WORCESTER PRESSED STEEL CO.'S METHOD OF ROUTING MULTIPLE-OPERATION JOBS

BY CHESTER L. LUCAS[*]

To start sheets of heavy steel at a blanking and drawing press at one end of a row of presses and keep the semi-completed shells moving down the entire line of drawing presses, passing the work from operator to operator, until it emerges after the thirteenth operation a completed steel bowl, is a feat of modern press work of which the Worcester Pressed Steel Co., Worcester, Mass., may well be proud. Fig. 1 shows the line of presses used on this work, and Fig. 2 represents a section of the connected presses, showing how the work is passed from press to press.

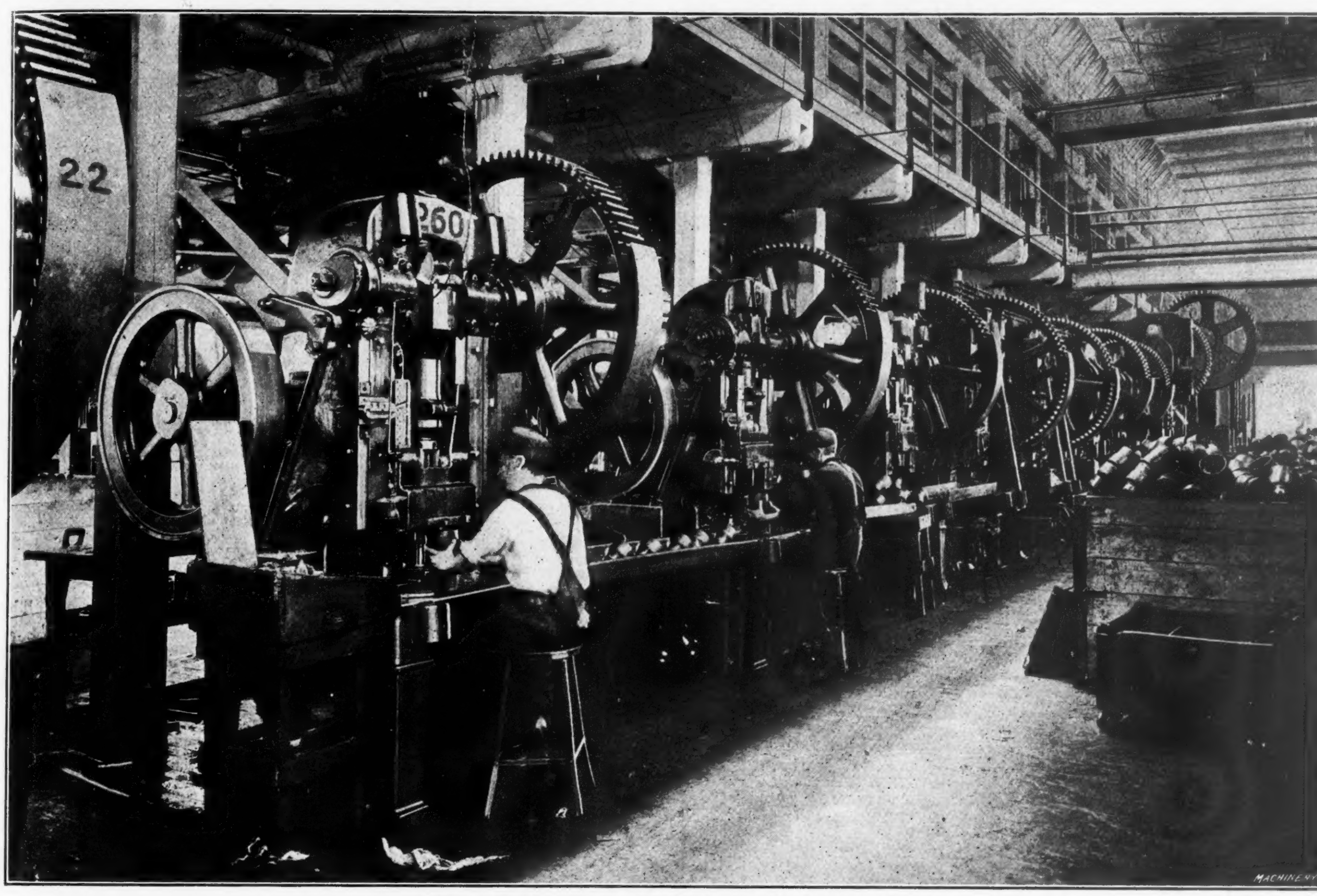


Fig. 1. The Presses used in Producing the Steel Bowls

The pressed steel bowl referred to is one which is used in large quantities on a special class of machinery. The completed bowl is approximately as shown in the line engraving, Fig. 3, being five inches in diameter. The fact that the stamping is made from heavy sheet steel, 0.150 inch thick, is the point which makes the production of this piece the more remarkable. The successive steps in drawing the shell

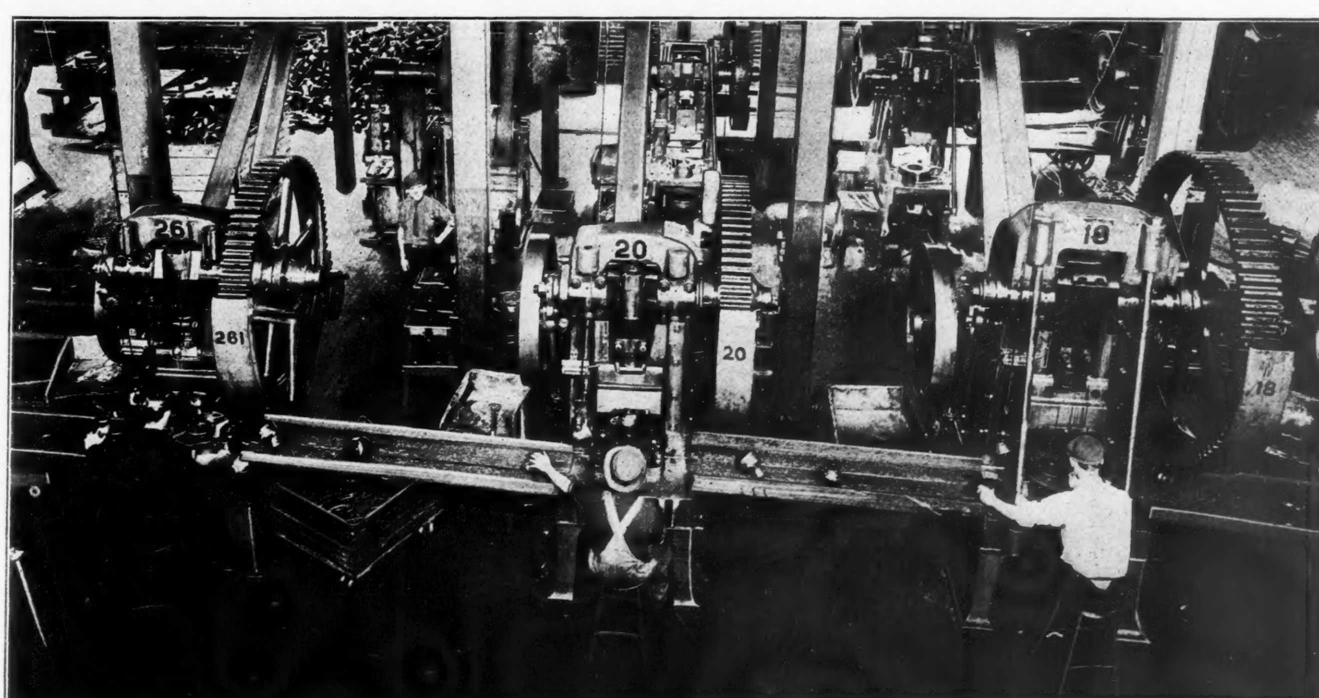


Fig. 2. A Section of the Row, showing Method of Handling the Work

[*] Associate Editor of MACHINERY.

are clearly indicated in the group illustration, Fig. 4, which shows the results of the work performed in each of the thirteen operations. By comparing the work with the two-foot rule shown in the foreground, a good idea of the dimensions of the pieces can be obtained.

The first operation, namely, that of cutting and drawing the blank, is performed on a large double-action power press, and after leaving this press the shells go to a large single-action press. Another reduction follows which leaves the blank deeper, but smaller in diameter. After this stage the shells are annealed and taken to the first press in the foreground of the illustration Fig. 1. From this point the shells continue down the line of presses, being passed from operator to operator by means of chutes along which the work is thrown. The method of routing the work is more clearly illustrated in Fig. 2. Before the shells are completed another annealing operation becomes necessary, because the final op-

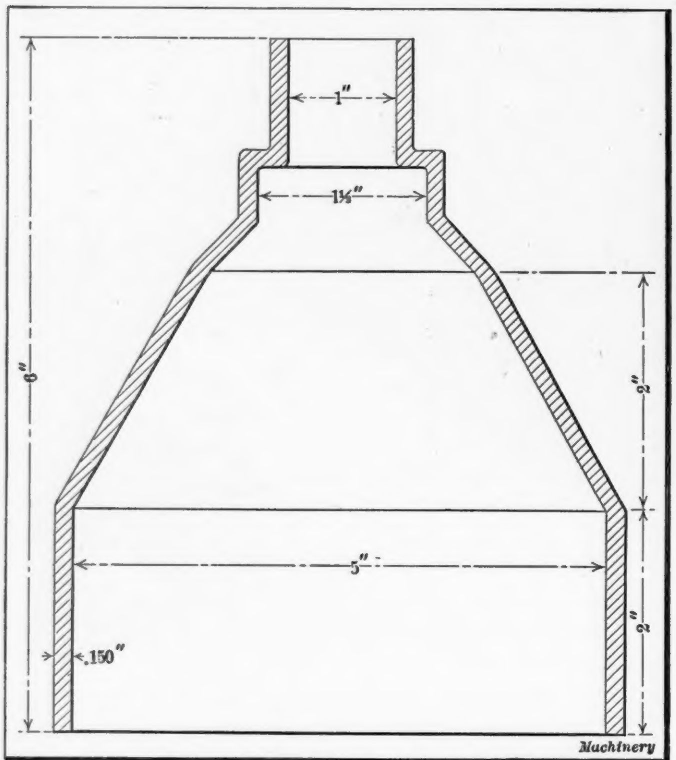


Fig. 3. Details of Steel Bowl

erations, which are for the purpose of setting the metal at the tip end of the shell, require that the stock be as soft as possible. Owing to their location it was impossible to clearly show two of the presses used for final punching and setting operations, but Figs. 1 and 2 adequately illustrate the principle of handling this job.

These shells are made in lots of from 5000 to 10,000, and after the presses are set up and the blanks started, the completed shells are turned out at the rate of 400 per hour. It is obvious that this method of handling press-work pushes the work off the floor and out of the way quickly. Piles

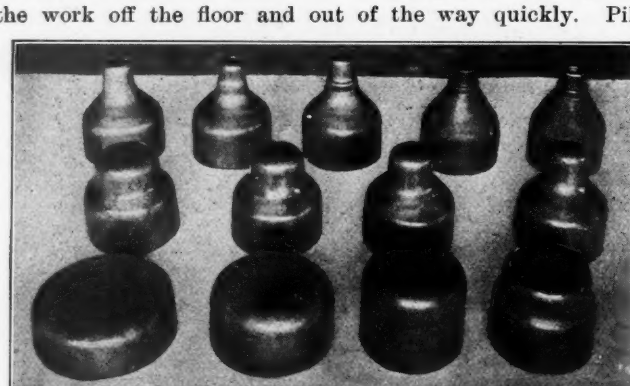


Fig. 4. Successive Steps in the Press-work

of half completed work do not accumulate, and once started, there is a steady stream of completed shells traveling to the shipping room until the last shell has gone "down the line."

In Fig. 5 may be seen a large Toledo double-action drawing press, a machine which handles drawing and forming operations on large work like brake drums, axle housings, cases, shells, etc. This press is one of the largest of its type ever built in this country and has a capacity for exerting a 1000-

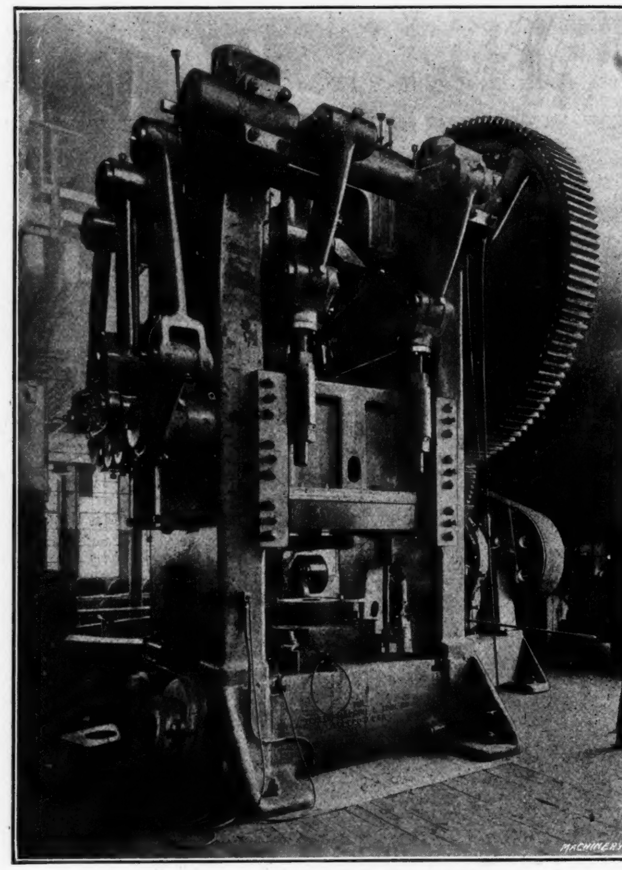


Fig. 5. The Large Toggle Drawing Press

ton pressure. The area of the bed is 60 inches square; the stroke of the plunger is 26 inches; stroke of the blank-holder is 18 inches. The crankshaft of this press is 12 inches in diameter, and the construction of the toggle mechanism is such that a long dwell under heavy pressure is given to the blank-holder. The advantage of this feature is that it provides means for drawing sheet metals with a minimum of trouble from wrinkling. The press frame is of the built-up type, rigidly bound together with forged steel tie-rods 6-inch diameter which have been shrunk into place. The power for operating is furnished by a 75-horsepower motor.

The premium system of piece work is employed on all

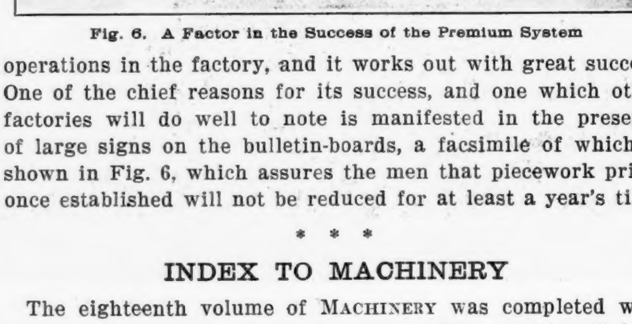


Fig. 6. A Factor in the Success of the Premium System

operations in the factory, and it works out with great success. One of the chief reasons for its success, and one which other factories will do well to note is manifested in the presence of large signs on the bulletin-boards, a facsimile of which is shown in Fig. 6, which assures the men that piecework prices once established will not be reduced for at least a year's time.

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INDEX TO MACHINERY

The eighteenth volume of MACHINERY was completed with the August number, and the general index covering the engineering, shop and railway editions is ready for distribution. Copies will be sent to any address on request.

PREVENTION OF ELECTRICAL ACCIDENTS IN MACHINE SHOPS

In an article in the *Engineering Magazine*, Mr. Emmett Campbell Hall deals with the question of electrical accidents and mentions some of the precautions that ought to be taken in order to avoid them.

Considering the extensive use made of electricity both for lighting and power in almost all modern industrial establishments, the general lack of knowledge concerning its dangers, and the not infrequent helplessness and panic which is manifested when someone receives an accidental shock, is somewhat surprising. Most electrical accidents are due to ignorance or carelessness, and not infrequently an ill-advised attempt at rescue results in a second accident. Scarcely less important than a knowledge of how to avoid a shock, is information as to what should be done if such accidents do occur, as they sometimes will through unavoidable causes, even when the greatest care is exercised.

The human body is an electric conductor, although not so good a one as a wire or a metal rail, and current will flow through the body when it is made part of a circuit. The amount of current which will flow through the body depends upon the voltage or pressure of the current, and upon the completeness of the contact between the body and the circuit. A single-cell battery, giving one to two volts, can cause a current to flow through the body, but the current is too small to be felt. A shock, though not a violent one, will be received from a 110-volt circuit; currents of greater strength must be carefully guarded against.

If a perfect insulator could be found, a man might stand upon it and place his hand upon a trolley wire through which a 500-volt current was passing, and receive no shock, because the circuit through the body would not be complete, and no current could flow. If a man should stand on damp earth and handle a charged wire with gloves slightly damp from sweat, he would probably receive a severe shock; if he wore no gloves, the shock would knock him down, and possibly kill him. There is no such thing as a perfect insulator, though for practical purposes a number of things may be so considered. The most that can be done is to insulate the body to such a degree that the current which passes through it will be so small that no shock will be felt. In other words, a small percentage of the total force of the current is almost sure to pass through the body, no matter what form of body insulation is used. It is therefore obvious that the amount of current which will get through the insulation increases as the voltage that is handled increases. It is not difficult to guard against shock from a 110-volt current, comparatively little insulation being effective. It is much more difficult to protect the body from 250 volts, and circuits of 500 volts or more should be carefully approached, no matter what form of insulation is used.

Next to contact with live wires, the most likely cause of shock is contact with parts of machines or equipment that are not supposed or intended to carry current, but which are accidentally charged with electricity. This charging is caused by the failure of insulation, or by a live wire coming in contact with the equipment. The frame of a motor or cutting machine, or the iron casing of an enclosed switch, may become alive and will be as dangerous as a trolley wire.

The frame of an electric locomotive is usually so completely in contact with the track rail that a man cannot get a shock even by standing on the rail and touching the locomotive; but this, under one peculiar condition, may not be true. If the rails have been heavily sanded, the locomotive may be almost completely insulated from them, and in that case a shock may be received from the locomotive frame or from the draw-bars of the cars coupled to the locomotive.

It is impossible to tell whether conditions are safe unless the man concerned has made them so himself—no one can tell by looking at a motor, for instance, whether or not the parts that carry current have come in contact with the frame of the machine. Whenever possible, common sense should dictate that the current be cut off before anything is touched that *might possibly* be charged. If it is impossible to cut off the current, or if repairs must be made to live apparatus, the only way to be safe is to provide something suitable to stand on while doing the work. *Dryness* is the most desirable quality in such an article. Perfectly dry boards, free from nails, are good.

Rubber gloves, or leather gloves in good condition and without metallic fastenings, will protect the body from shock. If the rubber covering of gloves is worn thin, the gloves give almost no protection, and the same is true of leather gloves which from any cause are damp. Rubber boots without nails in the soles or heels are good protection when new, but if the soles are worn or cracked their value is doubtful. Rubber tape on the handles of pliers and other tools cannot be depended on unless the tape has been freshly and carefully applied. If a man has to make some adjustment, he should use but one hand, if possible, and he should also try to place his body in such an attitude that the involuntary recoil from a possible shock will remove his hands from the apparatus instead of causing him to grasp it.

When a man has received a shock which renders him senseless, two things should be done as soon as possible; remove the victim from contact with the electric wire, and revive him by getting him to breathe. Great care should be exercised by the rescuer not to get a shock himself. If a switch is at hand, the current should, of course, be cut off, but if there will be any delay in cutting off the current, remove the body from the circuit by means of a piece of dry wood, using it to push the body aside or to lift from the body whatever is carrying current to it. Tools with *dry* wooden handles, such as picks or shovels, may be used for this purpose. The body can be safely grasped with the hands, if the hands are protected with several thicknesses of *dry* cloth, or if the rescuer stands upon a piece of *dry* wood. Take hold by the victim's clothing only, if practicable, not of the body where bare. If nothing else can be done, it may be possible to short-circuit the current, and thus blow the circuit breakers or fuses. A short circuit may be made by placing a piece of pipe or other metal article so that it will connect the two sides of the circuit. For instance, if the victim is in contact with a trolley wire, the wire, chain, or what not, should be thrown across the trolley wire and the track rail, so as to be in contact with both. In doing this, one must, of course, be sure that the pipe or chain leaves his own hand before it touches the current-carrying part of the circuit.

* * *

WAGES IN VARIOUS COUNTRIES

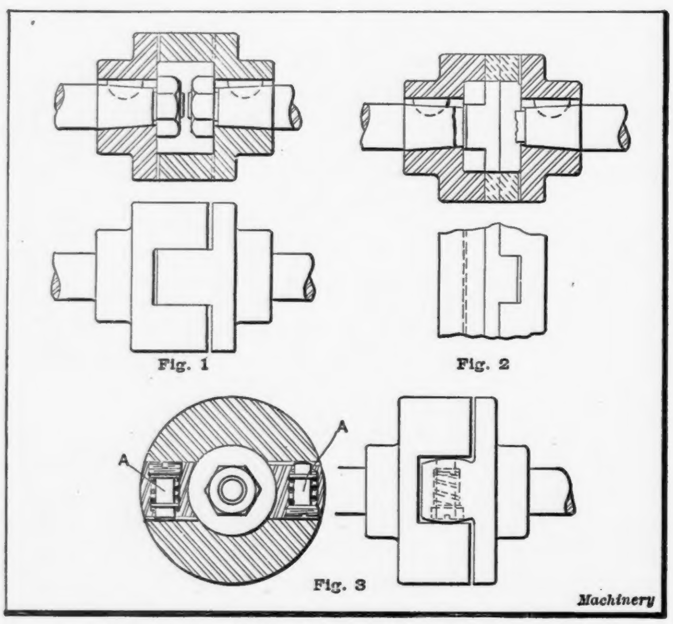
From the results of thorough investigations undertaken by the Board of Trade, England, relating to the wages paid to workmen in England, Germany, France, Belgium and the United States, some interesting data on the comparative wages in these countries may be obtained. These data present a fair average, as not less than ninety-four industrial centers in Great Britain, thirty-three in Germany, thirty in France, fifteen in Belgium and twenty-eight in the United States furnish the basis for the comparison. As a general average it may be stated that the wages of American workmen are 50 per cent higher than those of English workmen. In the European countries wages are highest in England and lowest in Belgium. English workmen are, in general, paid 25 per cent more than German workmen, and 36 per cent more than workmen in France. Relating to wages in the metal industries, the following figures will be of interest: Lathe hands are paid in London \$9.50 per week of fifty-four hours; in Berlin, from \$9.10 to \$9.45 per week of from fifty-seven to sixty hours; in Sheffield, \$9.25; in Düsseldorf, from \$8.00 to \$8.75; and in Antwerp, \$5.85, for sixty hours a week. Of European countries, England shows not only the highest wages paid but also the shortest working hours. Belgium with the lowest wages has also the longest working hours. The investigation also covers the cost of living in the different countries. Thus, for example, rents for similar accommodations are nearly twice as high in England as in Belgium, and about twice as high in the United States as in England. The average prices of food products as compared with the English prices are 17 per cent higher in Germany; 18 per cent higher in France; 1 per cent lower in Belgium; and 28 per cent higher in the United States.

AUTOMOBILE MAGNETO COUPLINGS

BY GEORGE E. POPE*

Recently a magneto coupling was to be designed which was to combine simplicity with full freedom of universal-joint action. Several designs were tried, the results obtained being recorded in the following.

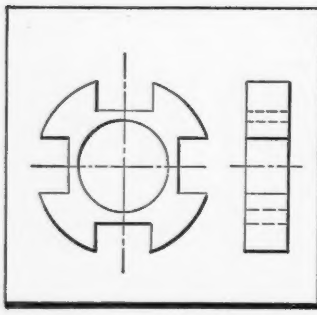
The first coupling designed was made as shown in Fig. 1, with the exception that the tongue was made about 0.010 inch smaller than the slot. This design, of course, had a universal-joint action, but the noise was very objectionable. This noise was partly due to the great difference in power transmitted while the armature of the magneto traveled by a gap as compared with that transmitted when it passed a pole. The objectionable noise was eliminated by making the tongue a sliding fit in the groove, as shown in Fig. 1, but this construction necessitated an accurate alignment of the magneto shaft with the driving shaft, and defeated the object of a universal-joint action. Another design, as shown in Fig. 2, was then tried. This is simply an adaptation of what is commonly known as "Oldham's" coupling. This worked



Figs. 1 to 3. Different Types of Couplings Designed

very satisfactorily and the only objection was that there was considerable milling work to be done on the intermediate piece.

The next step in the development was to make the tongue of the coupling shown in Fig. 1 with rounded sides, as indicated in Fig. 3. This arrangement gave a satisfactory universal-joint action, especially when the tongue was made 0.010 inch smaller than the groove and the spring pins *A* were added to keep the driving surfaces in contact. In this coupling, however, it is necessary that the tongues be milled properly; and the first operation in doing this work consists



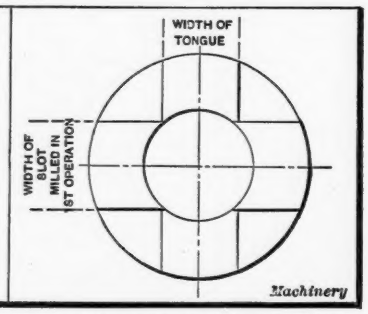


Fig. 4. Alternative Design of Connecting Part in Fig. 2

Fig. 5. Illustration of Method of finding Width of Tongue in Fig. 3

of merely milling a slot through the end as if the grooved part of the coupling was about to be made. The permissible maximum width of this groove or slot is readily determined, as indicated in Fig. 5. This slot serves a double purpose; *i. e.*, it relieves the form cutter of most of the work, and it provides a means for preventing the work from turning when milling the upper side of the rounded portion of the tongue, as shown in Fig. 6, where the cylindrical piece *B* enters into the groove milled while one side of the tongue is formed.

The fixture shown in Fig. 6 is, perhaps, of special interest, on account of its quick action in bringing the set-screws *C* into position. The piece carrying the set-screws is a section of cold-rolled steel placed between the uprights *A*, which take the backward thrust of the screws. These pieces are

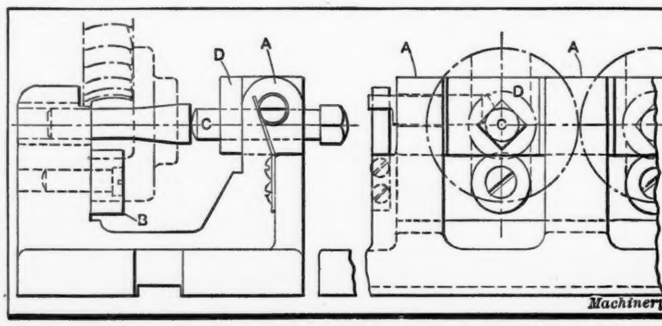


Fig. 6. Milling Fixture used for Milling Tongue in Coupling in Fig. 3

hinged freely at both ends on pins, the ends of which are milled off, as shown. These ends are in contact with flat springs which hold the parts *D* in an upright position with the screws vertical while the work (of which there can be six or ten pieces in the same fixture) is being removed or inserted.

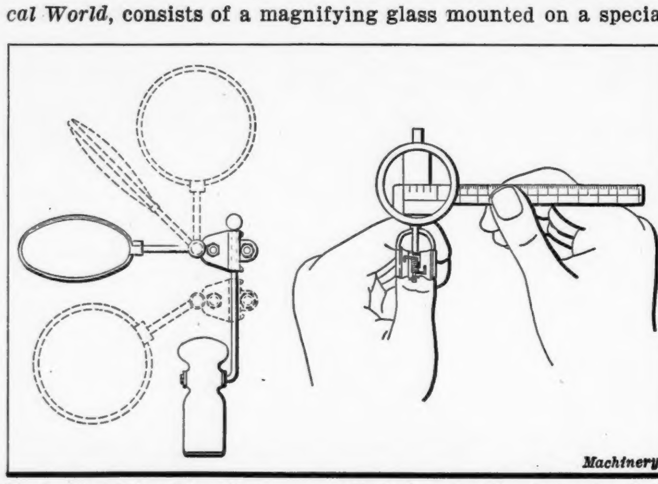
A slightly different design for a coupling of the type shown in Fig. 2 is to have the intermediate piece contain the slots, instead of the tongues. The intermediate piece will then look as indicated in Fig. 4. These pieces can then be milled in gangs on an arbor, but the other parts of the coupling become more difficult to mill, as both of them now have tongues, and it is doubtful if anything is saved by this design.

It may be remarked that although these different designs of couplings were made primarily for automobile magnetos, they probably can be applied to other kinds of work where it is inadvisable or impracticable to accurately align the connecting shafts.

* * *

HANDY MAGNIFYING GLASS FOR SHOP USE

The accompanying illustration shows a useful device recently placed on the market by Messrs. Pfeil & Co., Clerkenwell, London, E. C. This device, as illustrated in the *Mechanical World*, consists of a magnifying glass mounted on a special



Handy Magnifying Glass that can be attached to the Thumb, leaving Both Hands Free to handle Work and Measuring Instrument

clip which can be clasped onto the left-hand thumb, and is known as the "third hand." The object of the device is to enable an article to be held, examined and turned under the lens, and yet leave the other hand free for holding the measuring instrument. The clip can be clasped on any finger so that small articles can be examined on the palm of one hand and moved and turned around by the other. The illustration to the right suggests one of the uses of the device. As shown by the dotted lines in the illustration to the left, the magnifying glass is universally jointed to the holder so that it can be set in almost any position.

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COMMERCIAL GRINDING*

A FEW PRACTICAL EXAMPLES FROM ACTUAL WORK

BY F. B. JACOBS†

Where is the machinist of twenty or more years' experience who cannot recall the time when small and medium-sized shafts, spindles, etc., were always carefully turned from Bessemer steel and finished by filing? In those days, the few grinding machines that existed were generally of the universal type, and were confined to the tool-room, being used only on work that had to be corrected after hardening. While it can not be denied that the shop practice of the "good old days" resulted in excellent mechanics, it is also quite evident that the concern that still employs the old methods finds itself seriously handicapped in meeting prices set by modern practice. In the finishing of accurate machine parts, the grinding machine has replaced the lathe, and the grinding wheel has taken the place of father's file.

The present-day grinding machine owes the greater part of its success to the modern grinding wheel; for no matter how carefully the machine is designed and constructed, its output is always seriously handicapped if wheels of the wrong materials, grits, grades and bonds are used. The following illustrations and descriptions are not intended to show what could be done under ideal conditions; on the other hand they are taken from actual work as the writer found it in various shops under everyday working conditions.

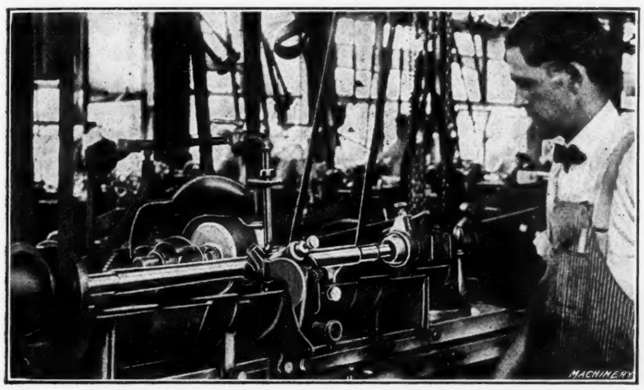


Fig. 1. Finishing Steel Shafts in a Brown & Sharpe Universal Grinder

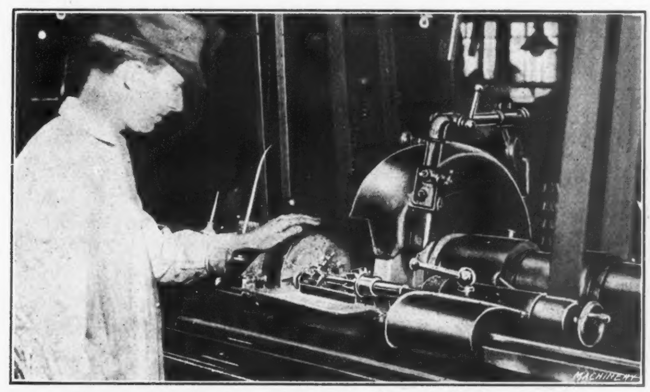


Fig. 2. Grinding Bevel Gear Hub with a Wide-faced Wheel

Fig. 3. Group of Bevel Gears being ground in Fig. 2

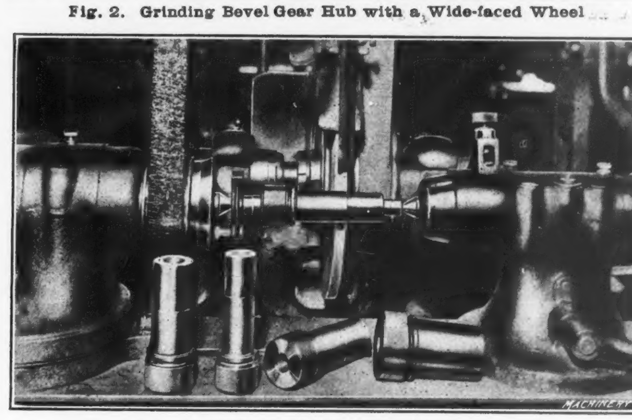


Fig. 4. Grinding Jig Bushings

In Fig. 1 is shown the operation of finishing a 40-point carbon steel shaft in a Brown & Sharpe No. 3 universal grinder, equipped with a carborundum wheel 365 grit, L grade, B3 plus bond. This piece is 2 feet 10½ inches long, and 1⅝ inch in diameter. It is first rough-turned, leaving 0.015 inch for grinding. As the illustration shows, the work is supported by a compound back-rest, this being necessary to overcome chattering under heavy cuts. While removing the greater amount of the stock the back-rest jaws are used "solid," bearing in a groove ground for this purpose. While taking the last few cuts the jaws are held against the work by the springs with which the rest is provided, care being taken to see that the jaws do not bear hard enough on the piece to throw it out of alignment. The time consumed in grinding this piece is twenty minutes, and the finish left is excellent.

The grinding operation shown in Fig. 2 is a radical departure from ordinary grinding practice, as the traverse feed is discarded except as a means of locating the work in its relative position with the wheel. The work consists of grinding bevel gear pinions used in the differential gear of automobiles, several of which are shown in Fig. 3. These are made of machine steel, pack-hardened. The surface to be ground is 1 7/16 inch long, and 1¾ inch in diameter. The grinding is done on a Norton plain grinder, equipped with an "Aloxite" wheel, made specially for this class of grinding. This wheel is 18 inches in diameter, 2-inch face, 5-inch hole, 246 grit, N grade, D-497 bond, and is run at a speed of 1400 R. P. M. Experience has shown that a saving of as high as fifty per cent of the grinding time is possible in grinding hardened steel pieces of comparatively short lengths by the method described.

As shown in Fig. 2, the work is held between the centers of the grinding machine on an ordinary mandrel or arbor, and is "dogged" in the regular way. The work speed is 140 R. P. M., and for removing 0.020 inch, the grinding time is 1¾ minute per piece. After locating the work between the centers, the operator brings the shoulder of the pinion to bear slightly on the wheel, and then, by means of the cross-feed screw, the wheel is fed directly to the work until the proper diameter is reached. This is shown by the graduations on the cross-feed. Before grinding, the wheel is carefully trued, and owing to its rapid cutting and accurate sizing qualities, many dozen pieces can be accurately finished without altering the adjustment of the cross-feed stop or re-truing the wheel. It may be added that grinding under these conditions is only in its infancy, and it can be safely stated that before many years have passed it will be common practice to use wheels as wide as six or eight inches for finishing work by the method described.

The grinding of jig bushings is an operation that calls for extreme care, otherwise the value of accurate spacing of the holes in the jig is lost. It is not intended, however, to convey the idea that the tool-maker should consume unnecessary time by carefully feeling his way along, because the tool grinding department can be made as efficient as any other, by the use of the proper wheels and methods. The bushings shown

*See also "Efficiency in Cylindrical Grinding," MACHINERY, March, 1912, and the articles there referred to.

† Address: Care of Carborundum Co., 826 Arch St., Philadelphia, Pa.

in Fig. 4 average one inch in diameter and are two inches long. They are made of tool steel, hardened, and drawn very slightly. The grinding is done on a Brown & Sharpe No. 2 universal grinder equipped with an "Aloxite" wheel 12 inches in diameter, ½-inch face, 5-inch hole, 405 grit, N grade, D-497 bond. This wheel is run at a speed of 1800 R. P. M. The bushings are held on special arbors as illustrated in Fig. 5. These arbors are straight and a wringing fit in the bushing for the greater part of their length. A slight taper at the

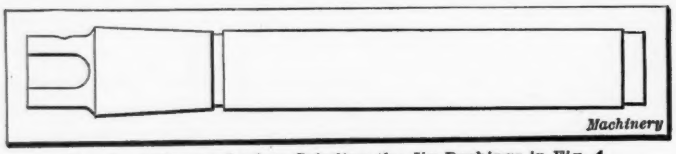


Fig. 5. Arbor used when Grinding the Jig Bushings in Fig. 4

end serves to hold the bushing from turning. The illustration shows this taper somewhat exaggerated, to illustrate the principle.

In grinding these bushings, a work speed of seventy-five feet per minute was used, while the traverse feed was the fastest that this machine was capable of giving in connection with this work speed, or one-quarter of the width of the wheel for each revolution of the work. Under these conditions the bushings were ground in five minutes each, which is very rapid when it is considered that the limit of accuracy is

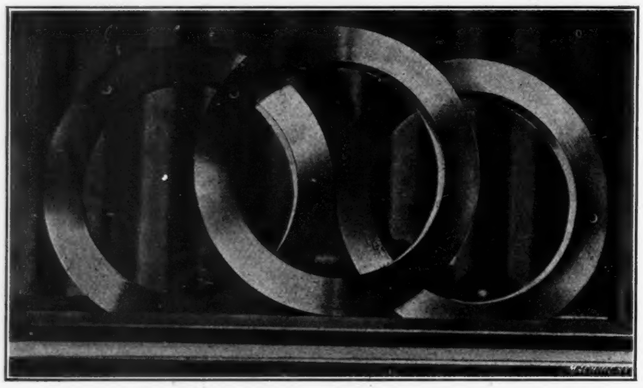


Fig. 6. Thrust Bearing Rings, 8 inches in Diameter, shown being ground in Fig. 7

approximately 0.0003 inch. The bushings were afterwards finished by lapping to fit the lining bushings.

The process of face grinding, or the finishing of the sides of pieces by holding them in a chuck on the universal grinding machine, and feeding them past the periphery of the grinding wheel, is by no means of recent origin, this method having been employed for many years in finishing tool work, such as the sides of milling cutters and other tools of like nature. In the last few years, however, owing to the rapid cutting qualities of the modern grinding wheel, face grinding

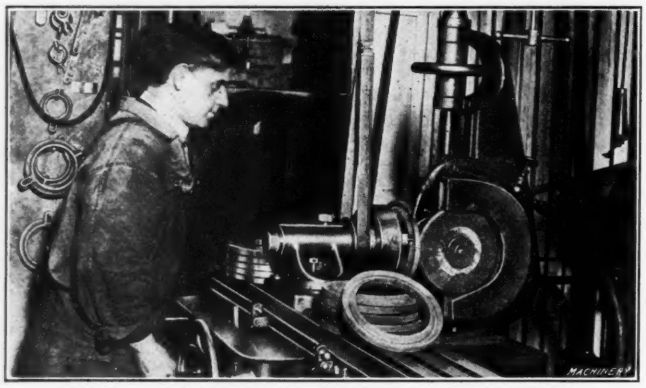


Fig. 7. Grinding Thrust Bearing Rings on a Bath Grinder

has become a regular commercial process. In Fig. 6 are shown several thrust bearing rings, eight inches in diameter, with a six-inch hole. These rings are made of machine steel, and, after being pack-hardened, are rapidly and economically ground on a No. 2 Bath universal grinder as shown in Fig. 7. The grinding wheel used is "Aloxite," 8 inches in diameter, ¾-inch face, 1⅜-inch hole, 365 grit, O grade, D-496 bond, and is run at a speed of 2300 R. P. M.

The work is held in a three-jaw chuck which is screwed firmly to the headstock spindle and set at an angle of 90 degrees with the wheel spindle. In locating the work in the chuck, the operator exercises care so as not to clamp the jaws too tightly; otherwise the pieces will spring out of shape. The work speed is 140 R. P. M. for both the roughing and finishing operations. In roughing, the operator feeds the wheel directly into the work until the sparks show heavy; then, by means of the traverse feed, the work is automatically carried back and forth past the wheel, the operator feeding the wheel into the work about 0.001 inch at each reversal of the platen. When the piece has been ground nearly to thickness the cross-feed is thrown out, the work still feeding past the wheel. This process, generally called "grinding out," gives an excellent finish even when a comparatively coarse wheel is used. Owing to the rapid cutting qualities of the modern grinding wheel, this is accomplished in five or six strokes. The grinding time for these pieces, including chucking, when removing approximately 0.010 inch, is five minutes, and the finish left is excellent.

* * *

STRENGTH TESTING OF STEELS

In a paper on "Research of the Hardness of Steel," read by Capt. C. Grard before the congress of the International Association for Testing Materials held in New York City, September, 1912, an investigation into the accuracy possible with the Brinell hardness testing method was recorded. From this investigation it appears that when commercial apparatus, as ordinarily used for making the Brinell test, is employed, and the test is carried out with ordinary care and precaution, it is reliable within an error of five Brinell units above or below the actual hardness. In other words, if the hardness of two pieces of metal is tested, and the difference on the Brinell scale is more than ten hardness units, it is certain that there is an absolute difference in the hardness of the pieces tested. With regard to the conditions under which the tests should be made, it may be stated that the pressure should be gradually applied during a time of two minutes or more, and the pressure should be kept on the test piece for a period of at least five minutes.

As has already been pointed out by Mr. Brinell himself, and as mentioned in an article on "The Brinell Method of Testing the Hardness of Metals," published in MACHINERY, engineering edition, September, 1908, this method of testing the hardness of metals offers a convenient means of ascertaining, within close limits, the ultimate strength of iron and steel. This, in fact, is one of the most interesting and important results of this method of measuring hardness. In order to determine the ultimate strength of iron and steel, it is only necessary to establish by experiments a constant coefficient which serves as a factor by which the hardness numerals are multiplied, the product being the ultimate strength. The coefficients, as usually stated, give, when multiplied by the hardness numerals, the ultimate tensile strength of the material in kilograms per square millimeter. Of course, coefficients can easily be worked out by means of which the hardness numerals can be multiplied so that the strength can be obtained in pounds per square inch.

In Capt. Grard's paper, this relation between hardness and tensile strength was exhaustively dealt with, and the following coefficients are given for different grades of steel:

Steels, extra soft	$K = 0.360$
Steels, soft and semi-hard	$K = 0.355$
Steels, semi-hard	$K = 0.353$
Steels, hard	$K = 0.349$

It will be seen that these coefficients differ by but a slight amount and it was suggested by another member of the congress of testing materials that a uniform constant be adopted by the International Association for Testing Materials, which would be used for calculating the tensile strength directly from the results of the hardness tests. (A complete treatise on the Brinell hardness testing system was published in the September, 1908, number of MACHINERY, engineering edition. This article is reprinted in MACHINERY's Reference Book No. 62, "Testing the Hardness and Durability of Metals").

* * *

The oily superintendent is a slick proposition.

STANDARDIZATION OF AUTOMOBILE DRAWINGS*†

SIZE OF SHEETS, PROJECTIONS, LETTERING, ABBREVIATIONS, CROSS-SECTIONING, ALTERATIONS, DIMENSIONS, ETC.

The following items should be considered in connection with the standardization of automobile drawings:

1. Size of sheets. 2. Arrangement of views on the drawing and method of projection. 3. Character and weight of the lines on a drawing. 4. Style of lettering and numerals, and the size of same. 5. Abbreviations for names of materials. 6. Cross-sectioning. 7. Method of making records of alterations. 8. Placing of finish marks on drawings. 9. Methods of dimensioning. 10. Methods of noting working limits or tolerance. 11. Location of general notes on the sheet. 12. Length of undercut. 13. Checking instructions. 14. Notation for tap and die sizes. 15. Nomenclature of parts.

At the Chalmers Motor Co., Detroit, Mich., an effort has been made to develop a logical system of making drawings along the lines outlined. There is a need for general standardization of automobile drawings. This industry is no longer a matter of a few scattered factories—there are hundreds of plants concerned with the making of drawings for identical parts; yet there are probably not five men in the Society of Automobile Engineers who use the same system for making drawings. Nevertheless, there is a constant changing about among the draftsmen and members of the society. They go from one factory to another, and every time a change is made it is necessary for these men to become familiar with an entirely new system of drawings. This increases the chances for error and causes a loss of time. It forces a man to fill his mind with detail matters about drawings when, as a matter of fact, he ought to be concerned with matters of design only.

In addition, almost every company in the country has some parts made outside of its own factory. This is particularly true of forgings, brass castings and pressed steel parts. There are some manufacturers of these parts who handle the work for as many as fifteen automobile factories. Here is a chance for error on account of each factory sending a drawing of a different size, made to a different scale, with notes and instructions made out in a different manner, on different parts of the sheet. It is hardly fair to blame the workman for failing to read correctly one of these drawings, if it is different, as it often is, in every respect, from other drawings which he has been handling previously. No matter, however, who is at fault, the error is there, and it may impede production for a considerable length of time. Hence, there is little use to argue further as to the need of standardization of automobile drawings; it remains merely to discuss the methods now in use and to determine which methods ought to be adopted by all. The following is a record of the practice of the Chalmers factory, as already mentioned.

Size of Sheets

First, in the matter of the size of the sheets, five sizes are used. The first is the standard letter size, 8½ by 11 inches. All other sizes are developed from the first size; that is, all are multiples of 8½ by 11 inches, or of one of those dimensions. No. 1 sheet is always made with a wide blank margin at the left, on the short dimension and a narrower uniform blank margin on the other three sides. The drawing or sketch is placed on the paper to read lengthwise of the sheet. Sheet No. 2 is 11 by 17 inches, with a wide blank margin at the left, on the short dimension, and a narrower blank margin on the other three sides. The drawing is made to read lengthwise of the sheet. Sheet No. 3 is 17 by 22 inches, sheet No. 4, 22 by 34 inches, and sheet No. 5, 34 by 44 inches, with the same arrangement of margins.

These are the sheets which have been used up to this time. However, a change has been considered as follows: To use only sheet No. 2, which is 11 by 17 inches, drawing large objects to a reduced scale on this size sheet, with a statement of the scale used on the sheet margin, so that the drawing will be readily understood. The new method would do away with the necessity of having different sized sheets, and all of the books for shop use would be made up with one size of sheet. In making drawings of such parts as crank-cases, cylinders, etc., they would be drawn to a reduced scale with the machinery dimensions only placed on the sheet. Pattern drawings would, of course, be made full-size, and would be kept in the drafting-room for factory reference. One or two large drawings might also be placed in the tool-room or at some other convenient point, for reference after a job is started. All of the drawings in regular use, however, would be 11 by 17 inches.

In connection with the arrangement of the sheets, a standard stamp should be adopted. A stamp 9½ inches long by 2 inches wide, with space for name, notes, material specifications, heat-treatment, material, by whom drawn, traced, checked, and approved, standard parts, date, and the symbol number, should be used. This stamp is always placed in the lower right-hand corner and along the margin of the sheet. The upper right-hand corner has a space 2⅝ inches wide and as long as necessary, running down the right-hand margin of the sheet, and divided into three portions. This is the revision table; in this space all notations of corrections, the date of correction, by whom made, and the dimension or part corrected are recorded. This table has all of the changes made on any particular drawing, so that it can be referred to at any time; no matter how unimportant the correction, it is always recorded here.

Method of Projection

The second item is the arrangement of the views on the drawing and the method of projection. For simple drawings, three views are about all that are necessary, with perhaps the addition of the necessary sections. No matter how simple the piece, three views should always be shown. The third angle projection is used; this is the best, because it gives the person handling the drawing a clear understanding of the front, top and side elevations.

Character and Weight of Lines

The third point is the character and weight of lines on a drawing. All full lines should be at least 0.030 inch heavy. All dotted lines should be 0.020 inch, with a mean length of dot of 3/16 inch and a spacing not in excess of 1/16 inch. All of the borders should be 0.060 inch heavy. It is, of course, understood that plenty of ink should always be used.

Style and Sizes of Letters

Fourth, the style of letters and numerals and their sizes should be considered. The best practice is to have all letters or notations on drawings made in upper case type, vertical form, and of about 0.020 inch uniform weight of line. For letters, too, plenty of ink should always be used. All notes and instructions on the drawings should be underlined with practically the same weight of line. This not only makes the notes more emphatic, but also has a tendency to keep all of the lettering uniform. Every word should be started with a capital letter approximately 1/8 inch high, the balance of the word being written with smaller sized capital letters, approximately 3/32 inch high.

Abbreviations

No abbreviation should be made so short as to be confusing. When necessary, the word should be written out in full. Mistakes as to materials are about the most serious that can occur; here one cannot be too careful to obviate the chance of error. The following abbreviations are used:

For iron casting—"I. Cast."

For malleable casting—"Mal. Cast."

For steel casting—"St. Cast."

For brass casting—"Brs. Cast."

For bronze casting—"Brz. Cast."

For aluminum casting—"Alum. Cast."

* Abstract of paper by George W. Dunham to be presented before the Society of Automobile Engineers at its Winter meeting in New York, January, 1913.

† The following articles on drafting-room practice and kindred subjects have previously been published in MACHINERY: "The Printing Press in the Drafting-room," January, 1912; "The Drafting-room System of the American Locomotive Co.," June, 1911, and the articles there referred to. See also MACHINERY'S Reference Books No. 2, "Drafting-room Practice"; No. 8, "Working Drawings and Drafting-room Kinks"; and No. 33, "Systems and Practice of the Drafting Room."

The abbreviation for forgings is "Forg."; for steel stampings, "St. Stamp."; for pressed steel, "Press. St." In describing sheet metals always begin with the word "Sheet." This is no abbreviation at all, but it is best to use the full word, since it precludes all possibility of error.

Cross-sectioning

For all detail drawings, a cross-sectioning is used as if the material were cast iron, with lines 0.015 inch heavy, spaced 1/16 or 0.025 inch apart. On assemblies, however, the standard cross-section of various materials should be used. The different characters of sectioning are confined to assembly drawings.

Recording Alterations

The method of making records of alterations should be standardized, because workmen shift about a great deal, and all alterations should be uniform. When several different systems of noting alterations are used, it is impossible for a man to understand all of them without considerable explanation, and, of course, no man likes to confess ignorance of a drawing if he is used to working with drawings. When a figure is changed, a lower case letter should be located alongside the figure changed. This letter should be surrounded by a circle on the tracing; then the same letter should occur again in the upper right-hand corner where notation of alterations is made. Here the letter should be followed with the figure as it originally read, followed by the date and initials of the man who made the correction. In this manner all changes can be so recorded as to enable one to find the dimension as it was prior to the change, and also to discover when and who made the change. If this system were uniform for all automobile drawings, there would never be any confusion in regard to alterations.

Finish Marks

Next we come to the matter of placing finish marks on drawings and to the right lettering to be used. The Chalmers Motor Co. uses the capital "F" with the foot of the letter resting on the line indicated as finished. However, a very good practice in use in other shops, is the placing of a lower case "f" with the cross bar on the intersection of the body of the letter and the line to be finished. Of course care should be taken to see that the letter is always placed at right angles to the line, otherwise the intersection will be less noticeable, and the letter may be overlooked. The method of showing the amount of finish on the drawing is followed by some, but this is inadvisable, as the amount of finish is dependent on the methods used in the shop and changes as the routing system may be altered from time to time.

Methods of Dimensioning

All dimension lines should be 0.015 inch heavy, and should be placed outside of the views, as far as possible. Elevations and end views of an object to be dimensioned should be tied together with projection lines of the same weight as the dimension lines, with the dimensions placed between. All diameters of holes occurring in the body of the drawing should be carried out for dimensioning with full projection lines. Never place the diameter of a hole inside the hole itself, except when the hole is very large. Numerous diameters should never be marked transversely across the face, with the dimension lines intersecting a common center.

All dimensions should read from the bottom and right-hand side, as far as possible. It is not necessary in motor car work to add the customary inch marks to the figures. Section through threads should be shown with two parallel lines approximately the depth of the thread. The customary method of showing threads by inclined lines should be avoided. This has a tendency to blur a drawing badly.

Tolerances

There should be an understood allowable variation or tolerance in rough forgings and castings where a dimension is shown in a common fraction; on finished work where a common fraction is given; and on finished work where a decimal is given. Very close limits or tolerances should be shown by writing the maximum and minimum dimensions allowable, in decimals. These decimals should be written in full, and not with plus or minus marks as is often done. They should be uniformly written, one above the dimension line and the other underneath. For example, for a piece of one and one-half inch diameter, with a minus variation of 0.003 inch, 1.500 should be written above the dimension line and 1.497 underneath.

Notes

Notes should be grouped in one part of the sheet, either in the left- or the right-hand lower corner, as may be thought best. If this manner of making notes is followed generally, workmen will become accustomed to look for notes in a certain part of the drawings. This will eliminate the chance of overlooking important notations, often with embarrassing results.

Length of Undercut

The twelfth item is the diameter and length of undercut at the end of a threaded part or ground shoulder. In most work the undercut is just sufficient to permit the grinding wheel or thread tool to clear itself, and in the case of a ground dimension it is generally necessary to allow at least ⅛ inch in length—sometimes more, if conditions will permit. For threading operations it is well to allow 1/8 inch, although 3/32 inch has been used very successfully.

Checking Instructions–Tap and Die Sizes—Nomenclature

Thirteenth comes the matter of checking instructions. These should be carefully outlined and rigidly followed.

The checker should be instructed to check for general appearance of the drawing. If this is done, the condition of the work turned out of the drafting-room will be kept up to the highest standard. Undoubtedly the quality of the drawings has a very decided effect on the quality of the work in the factory.

All drawings should be checked very carefully for design. If there is any question in a checker's mind as to the design, he should call the matter to the attention of the chief draftsman at once.

All drawings should, of course, be checked for accuracy, and for working limits.

Particular care should be taken that all figures necessary to make the piece are on the drawing.

The finish marks should be carefully checked.

All drawings should be checked for threading and grinding reliefs.

Instructions for hardening, tempering, annealing, plating and polishing should be checked with the utmost care.

Material specifications and treatment require most careful checking.

The general notes should be gone over.

There should be a check on standard parts going with any particular part.

The name and, finally, the number should be checked.

The fourteenth point concerns tap and die sizes. Tap and die sizes should be given together with the pitch diameter and tolerance, wherever possible.

The nomenclature of parts is now under discussion in the nomenclature division of the standards committee of the Society of Automobile Engineers, and this is a matter to which reference can be made first when this committee has completed its work.

* * *

PROPOSED BUREAU OF FARM POWER

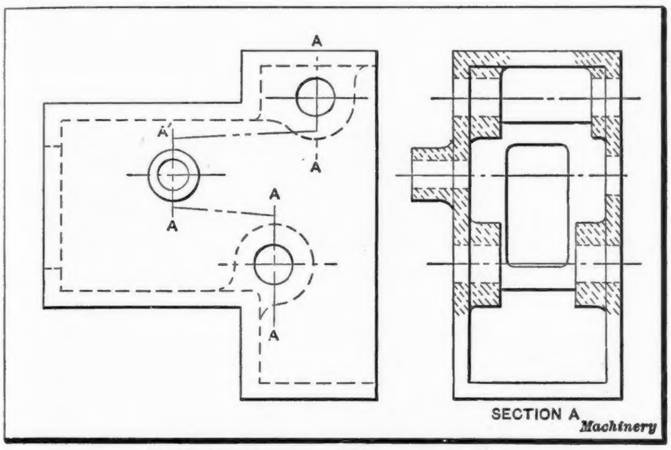
A bill has been brought into the House of Representatives (No. 25,782) by Mr. Henry T. Rainey, with the object of establishing a Bureau of Farm Power in the Department of Agriculture. It is the purpose of the bill to create a bureau which will investigate and report to the Department of Agriculture upon all matters pertaining to the methods of furnisning power on farms, and on all labor-saving machinery adapted for use on farms. This bureau would investigate such subjects, for example, as the use of electricity, gasoline, and steam in propelling farm vehicles, in operating plows, reapers, mowing machines, thrashing machines, and other farm machinery. In general, the bureau should make reports upon all such devices which would tend to lessen the amount of labor necessary in agricultural pursuits, and the expense of producing and marketing farm products.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DENOTING SECTIONS ON DRAWINGS

In denoting the points at which sections are made it is customary to place different letters at each point and refer to these letters in the title of the view showing the particular section, thus: section at *AB;* section on *ABC;* section through *ABCD.* The method employed by the writer is to use one letter only for any particular section. Every break and the ends of a section are denoted by the same letter, as shown in the accompanying engraving. The section is then referred to simply as section *A*, section *B*, etc.



Method of Denoting Sections on Drawings

J. COULSON

[The illustration shows a feature of drafting practice not used by draftsmen as much as it could be advantageously, that is, showing the cross-sections of a piece with dotted lines instead of full lines. This use of dotted cross-sections enables the object to be drawn in full lines as though not sectioned, and thus to show in the same view sections on any parallel plane without interfering with the remainder of the drawing. The dotted sectioning is shown in the cross-section at the right in the above illustration.—EDITOR.]

BURNISHING THREADING DIES

In the July number of MACHINERY a contributor recommends the passing of a master threaded plug through dies as a means of smoothing the threads of the dies. This operation is to be performed both after cutting the thread, while the die is still in its soft state, and after hardening. Lard oil is used as a lubricant, but no mention is made of an abrasive.

If one might judge from the effect of running a hardened spindle in an ordinary journal under dry conditions, the effect of the treatment outlined, on the threads of the die, might be thought to be similarly disastrous; because before the plug could act as a burnisher the oil would necessarily have to be squeezed from between the thread surfaces. In the opinion of the writer the removal of 0.001 to 0.0015 inch would tend to tear the thread. If the material is not removed, but simply compressed, the stresses set up in this way would certainly increase the tendency to distort in hardening.

It is also said that another advantage is gained in that the lead of the threads, distorted in the hardening process, is corrected. Now, as the die has been gashed or fluted at the time of the second burnishing operation there would be a tendency for the die to cut the master plug. At any rate, its influence on the master plug would, perhaps, be greater than the influence of the master plug upon the die thread; thus the pitch of the plug would be altered, it seems, at the same time that a correction, or rather a partial correction, of the lead of the die thread was made. Hence this advantage seems of doubtful value, and would almost require the making of a new plug for each die made, which would scarcely pay.

It would seem that the burnishing should rather be left to be done by the work to be cut by the die itself; or, let the die be used at first on a piece of soft material, such as cast iron. It is well known that cast iron has a burnishing effect. In lapping, for instance, a cast-iron plate merely kept wet with benzine is not only a burnisher, but a comparatively fast abrasive. The writer has before him at the moment of writing several dies in which the threads are quite smooth and bright. The only burnishing process to which they have been subjected is use.

Manchester, England. FRANCIS W. SHAW

THE DROP WORM-BOX

An article in the May number of MACHINERY prompts the writer to record some troubles experienced by him in connection with the drop worm-box form of trip motion. The accompanying engraving Fig. 1 shows the most common form, provided with a slight improvement. As pointed out in the previous article, the worm-box often fails to release when the feed shaft runs in the direction denoted by arrow *A*, the tendency being for the worm to cling to the worm-gear.

As a means of obviating this difficulty, the former contributor suggests placing the reversing motion in the worm-box, arranging it in such a way that the feed shaft always would turn in the direction of arrow *B*. This arrangement, however, is not always possible, since the reversing mechanism may have other duties to perform, as in the case of a turret lathe having a turret and a cross sliding saddle, both of which need to be reversed at times. Hence, some means of overcoming the difficulty other than by placing the reverse in the worm-box is necessary.

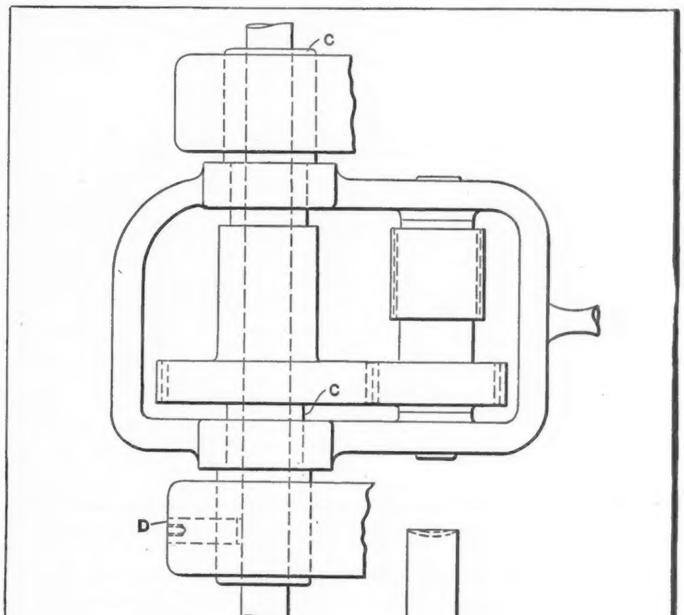


Fig. 1. An Improvement in the Ordinary Design of a Drop Worm-box

One method adopted by the writer made use of a sufficiently powerful spring to depress the worm-box after releasing. In Fig. 1, however, is shown how the difficulty was met without

using the spring. Usually the worm-box is mounted directly on the feed shaft, in which case the reaction of the pressure increases the friction on the feed shaft to a sufficient extent to squeeze out the oil film, thus increasing the coefficient of friction. The shaft itself then tends to pull the worm-box upwards, in addition to the direction of pressure at the teeth of the gear. By pivoting the worm-box on bushings at *C*, the friction between the shaft and worm-box is entirely eliminated. In the case in question the trouble entirely ceased with this construction, and springs were not needed.

An additional advantage of this method of pivoting is that the endwise adjustment for allowing the parts of the trip motion to be placed as required is provided. The method of holding bushing *C* is by means of pins *D* having small tapped holes in order to make possible their withdrawal.

Another case in which trouble was met with is shown in Fig. 2. In this case the worm-box contained a two-speed arrangement as shown. The sliding gears were moved by the shipper and rod shown by the dotted lines at the bottom. As the apron in which the worm-box was fitted was sliding along the bed, the endwise friction gradually tended to force the gears to disengage. The sliding gears were simply mounted directly on the feed shaft at that time. By imposing bushing *B*, which fits endwise between the bosses inside of the worm-box, this difficulty was overcome. Key *A* engages with a

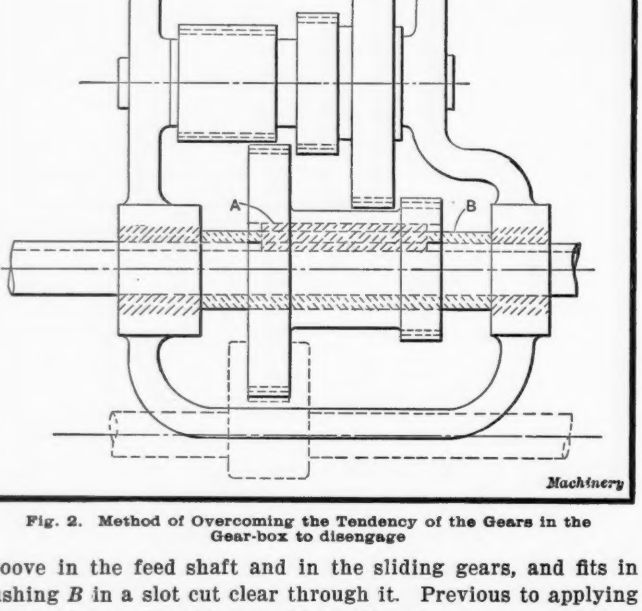


Fig. 2. Method of Overcoming the Tendency of the Gears in the Gear-box to disengage

groove in the feed shaft and in the sliding gears, and fits in bushing *B* in a slot cut clear through it. Previous to applying the bushing *B* the shipper which slides the gears was locked by friction. The faces of the shipper which make contact with the large gear, however, were badly cut up.

J. COULSON

TO ANNEAL AND HARDEN HIGH-SPEED STEELS

Place the piece to be annealed in an iron pot or pipe, pack steel chips around it, ramming them tight, and lute the cover well with fire clay, heat to a lemon yellow and hold the heat six to eight hours. Place the box in charcoal ashes and leave until cold.

Tool bits and small tools made of "Cyclone" special high-speed steel can be hardened successfully by heating to a yellow white heat and quenching in a good size piece of beef suet; plunge the piece into the suet and leave until cold; it will be found hard and tough.

To anneal "Blue Chip," "Novo" and "Rex" high-speed steels, pack the piece in an iron box or pipe with slacked lime rammed tightly around it and lute the box with fire clay. Heat to a yellow and hold the temperature one hour, and then bury the box in charcoal ashes until cold; or, if a blacksmith's forge is used with charcoal for fuel, leave it to cool down with the fire.

Another method is to pack the piece to be annealed in an iron pot or pipe with cast-iron chips and charcoal dust, or burnt molding sand, half-and-half. Ram the mixture well around the article, taking care that there is at least an inch of packing material around each piece. Lute the cover with fire clay and heat very slowly to an orange color. Hold the heat fifteen minutes and bury the box in slacked lime or charcoal ashes until cold. These formulas have all been tried and have given excellent results.

W. C. BETZ

New Britain, Conn.

PRACTICAL METHOD OF MANUFACTURING DOUBLE-ANGLE END-MILLS

A great deal of trouble is often experienced when manufacturing small double-angle end-mills by ordinary methods. It is difficult to align the teeth properly, because of the necessity of resetting the machine when milling the second angle.

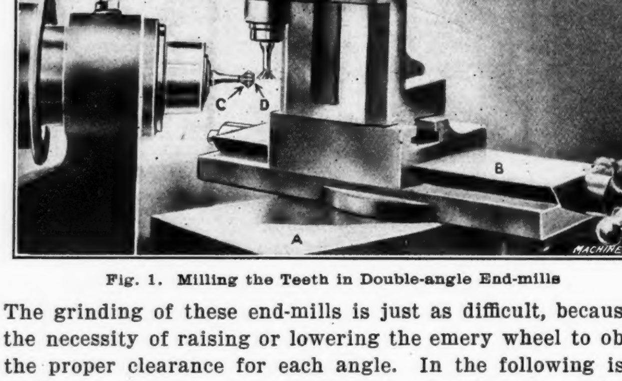


Fig. 1. Milling the Teeth in Double-angle End-mills

The grinding of these end-mills is just as difficult, because of the necessity of raising or lowering the emery wheel to obtain the proper clearance for each angle. In the following is described a method of manufacturing double-angle end-mills without the use of special machinery, so that both angles may be milled at one setting with the same milling cutter without readjustment. This, of course, insures the proper alignment of the teeth. The grinding operation of both angles is performed in the same way.

In Fig. 1 is shown a No. 4 Elgin bench lathe with milling attachment, as manufactured by the Elgin Tool Works, Elgin, Ill., set up for performing the milling operation. The spindle of the milling attachment is set in a vertical direction and the milling cutter is set central with the work. The lower slide *A* is set at the right angle to mill the cutting surface of

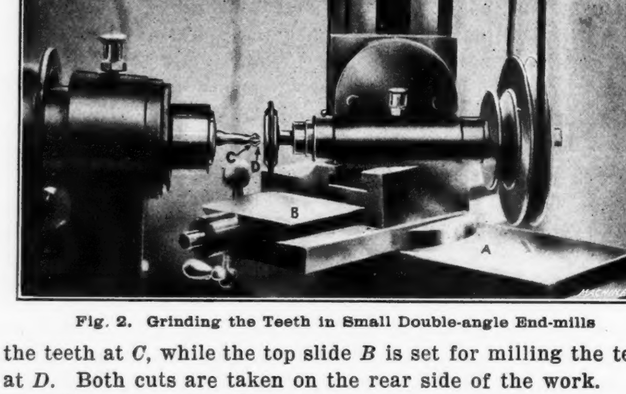


Fig. 2. Grinding the Teeth in Small Double-angle End-mills

the teeth at *C*, while the top slide *B* is set for milling the teeth at *D*. Both cuts are taken on the rear side of the work.

In Fig. 2 is shown the grinding operation, which is done in much the same way, except that slide *A* is used for grinding the teeth at *D*, and slide *B* for grinding the teeth at *C*. The spindle of the milling attachment in this case is set in a horizontal direction, with its center line below that of the cutter, so as to provide proper clearance for the teeth. The emery wheel is dressed flat on the top with a short angular surface on each corner. These surfaces correspond to the angular surfaces on the cutter, thus making it possible to grind both

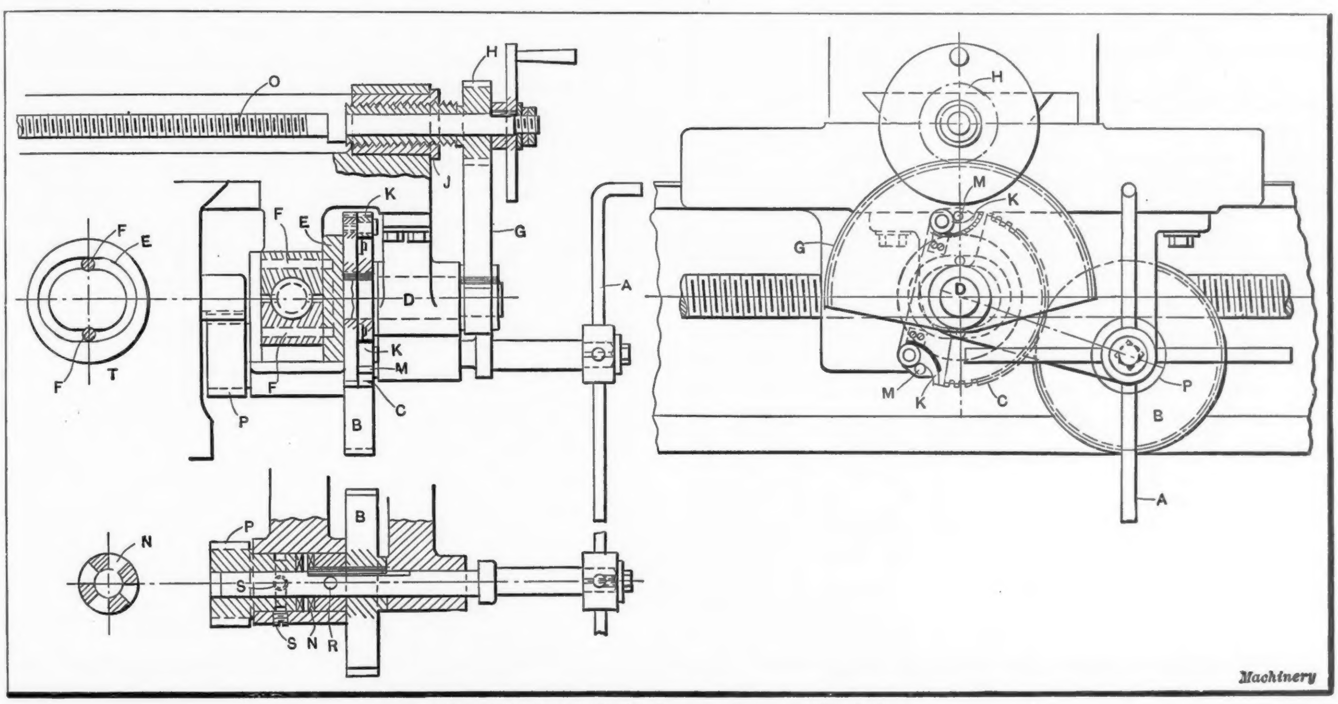
angles at the same setting of the wheel. As the spindle of the attachment is parallel with the axis of the lathe spindle, the extreme sharp point of the cutters can also be blunted by the wheel without resetting by setting the pulley of the grinding attachment over and turning the attachment into a traverse spindle grinder.

Left-hand cutters may be made by this method as well as right-hand. The illustrations show the making of a double 45-degree angle end-mill. Regular angular cutters may be made in the same way by substituting an arbor chuck for the taper chuck being used. The lathe-head index plate is used for the indexing, and as the slide-rest is graduated, it is a simple matter to duplicate the work at any time.

Chicago, Ill. MILTON C. TAYLOR

NOVEL CONSTRUCTION OF APRON MECHANISM FOR SCREW-CUTTING LATHE

The accompanying illustration shows an arrangement used in the apron of a screw-cutting lathe, by means of which only one handle *A* is needed to manipulate the carriage when cutting threads. When one cut is finished it is only necessary to turn handle *A* about one-quarter of a revolution, and the tool is withdrawn from the work. The half-nuts are also unclasped from the lead-screw at the same time, and by pushing handle *A* inwards, the rack-pinion is brought into mesh with the rack so that the carriage can be moved back and another cut begun. To bring the tool back into position, simply pull out the handle and turn it back about one-quarter of a revolution. This both clasps the half-nuts on the lead-screw and brings the tool back to the work.



A Novel Design of Mechanism for Screw-cutting Lathe

When handle *A* is turned, gear *B* turns sector *C*, which is keyed to shaft *D*, on the end of which is cam *E*. The two pins *F* passing through the half-nuts fit in a slot cut in cam *E* and open the nuts. The sector *G* is also turned; this meshes with gear *H*, which is threaded into bushing *J*, fastened to the carriage. Hence, screw *O* is withdrawn and the tool-slide with it. When the half-nuts are opened, sector *C* is in such a position that spring catch *K* only is in engagement with gear *B*. Hence, if this gear is turned further, the catch simply slips so that the handle can be turned around and the carriage brought back with the rack-pinion in engagement with the rack without moving the half-nuts or withdrawing the tool any further. The spring catch *K* fits against pin *M*, so that when gear *B* is turned back it pushes against the catch and brings the sector into mesh with gear *B*, thus closing the half-nuts and bringing the tool in to the work. There are two of these spring catches, one at each end of the sector, so that the carriage can be moved either way, according to whether a right- or left-hand thread is being cut.

In the illustration, the sector is shown in the position it occupies when the nut is closed and the tool is in engagement with the work. In the lower left-hand view is shown a section through the rack-pinion shaft. When the handle *A* is first turned the teeth of clutch *N* are out of engagement with the clutch teeth in the rack-pinion, so that *B* is turned without turning this pinion. When handle *A* is pushed in, however, the shaft and clutch *N* are moved along until the teeth of the clutch engage with the clutch teeth in the rack-pinion. Clutch *N* is fastened to the shaft by pin *R*, and screws *S* hold pinion *P* in position, allowing it simply to revolve on its shaft. When the saddle is moving along when cutting the threads, clutch *N* is out of engagement with the rack pinion, and pinion *P* only revolves. At *T* is shown the slot in the cam for the pins in the half-nuts.

Manchester, England. W. R. OAKES

SYSTEM FOR ALTERING DRAWINGS

In the course of his work in the drawing-room the writer has often had occasion to change large portions of assembly drawings or complicated details. This requires a great deal of time and energy. Below is described a system which has been used to great advantage in cases of this kind.

Suppose that the design of a machine has been changed, which will require the erasing of some details and the drawing of new ones in their places, or making an entirely new drawing, which may not be convenient at the time. First of all make a good Vandyke negative from the tracing; then using a black crayon, mark out every line that is not required in the new drawing, taking care to mark out the lines on both sides of the negative, as otherwise they are likely to show up later. Then make a good black-line print from the Vandyke, using a paper with a smooth surface; this print will now show blank places where the lines were marked out with crayon. Now draw the new parts in ink just the same as if the tracing were altered, and make a blueprint from this black-line print. This will be as good as one made from a tracing. The write print is now filed with the tracings as an original drawing.

One of the chief advantages of this system is that the original tracing is kept intact, and in case it has to be referred to in the future, one does not have to depend on finding an original record-print, but can refer directly to the tracing. From personal experience the writer has found this system to save at least half the time required to change a tracing. and, whereas a tracing can seldom be changed more than once, under this system as many changes as required may be made.

This system is also useful in connection with drawings

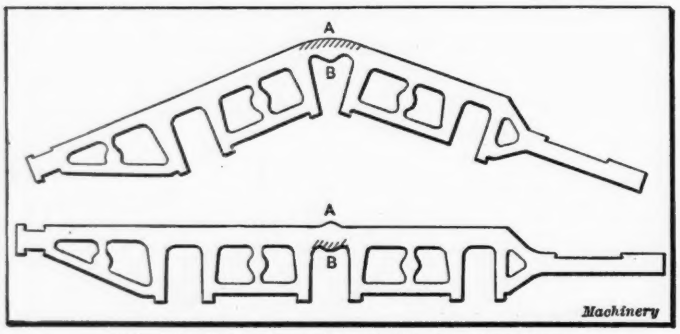
that are changed continually according to specifications. In this case, make the tracing complete in every respect, including dimension lines, but no dimensions. Then make from this a black-line print and fill in on the latter all the dimensions and notes necessary for the shop. Make a blueprint from this print and file the black-line print as a tracing. This does away with the possibility of losing the record-print when marking up blueprints, as is often the case.

Philadelphia, Pa. EDWARD ROBINS GLENN

[See also an article entitled "Changing Drawings Quickly," published in MACHINERY, October, 1907.—EDITOR].

SHORTENING A CAST-STEEL LOCOMOTIVE FRAME

Locomotive frames are usually made of steel castings and weigh from two to four tons each. They are from 25 to 30 feet long, and the top rail has a rectangular section of from 5 by 7 to 6 by 9 inches before finishing. Sometimes, owing to variations in the methods of casting, or improper shrinkage allowance in the pattern, these castings are either too long or too short to true up when machining. It is simple enough to lengthen a frame under a steam hammer, but it is not



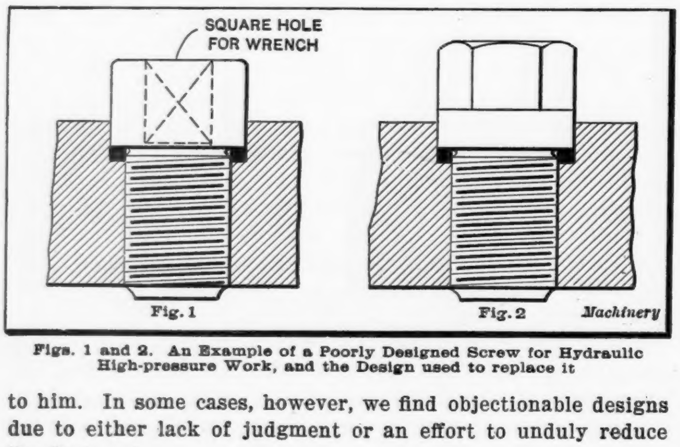
Method for shortening a Cast-steel Locomotive Frame

possible to shorten it by this means. The usual method for shortening a frame is to heat it between two of the pedestal legs, as at *A* and *B* in the illustration; then, by cooling the edge *A* and bending the frame across the anvil, the metal will upset at *B*. The frame is then heated again and cooled at *B*, after which it is straightened. The metal will be upset at *A*, thus shortening the frame. In the two heats a reduction of from ½ to ¾ inch may easily be obtained. It is evident that if the bending were done in the opposite direction, relative to the parts being cooled while bending, the frame would be lengthened instead of shortened.

Rochelle, Ill. J. H. MAYSILLES

AN EXAMPLE OF POOR DESIGN

The designer is often blamed for poor designs when he has done his very best to compromise between the conflicting practical requirements, and between conflicting orders issued



Figs. 1 and 2. An Example of a Poorly Designed Screw for Hydraulic High-pressure Work, and the Design used to replace it

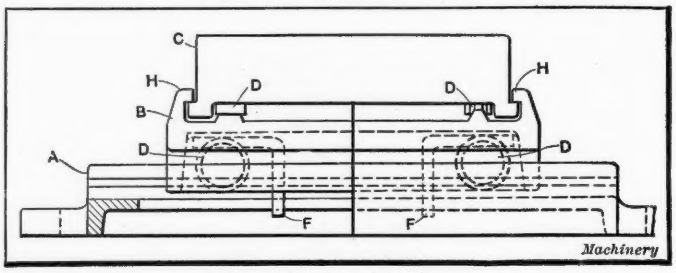
to him. In some cases, however, we find objectionable designs due to either lack of judgment or an effort to unduly reduce the first cost.

An intensifying hydraulic pump failed to reach the desired pressure on account of leakage. The leak was through the stop-screw on the delivery valve on the high-pressure side. With the idea of a quick repair, the screws on the suction side and the high-pressure side were changed. In tightening the leaking screw on the suction side, however, it broke off. The screw was designed as shown in Fig. 1, and the cause of the defect is easily seen. The section of metal at the bottom of the head is very thin and the leakage took place in this square hole in the head of the screw. The screw was replaced with the type shown in Fig. 2, which was made from a solid bar. The screw shown in Fig. 1 was of cast brass, which is objectionable for hydraulic high-pressure work because it is liable to be of a porous texture.

London, England A. L. HAAS

A TAPPING FIXTURE

The accompanying illustration shows a tapping fixture which is easily operated and which can be used for a wide range of work. It consists of a baseplate *A*, bolted to the table of

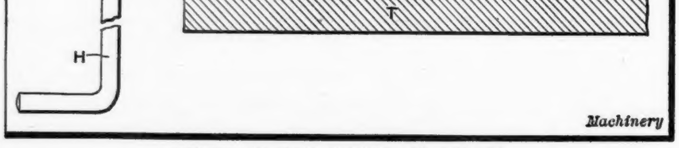


A Convenient Tapping Fixture

a drill press with a tapping attachment, and a center plate *B* and top plate *C*, which are each provided with two plain and two grooved rollers *D*, rolling in tracks at right angles to each other. In this way it is possible to move a piece of work clamped to the upper plate to any position, without having to shift it on the table itself. Stops *F* are provided to prevent the plates from over-running. The overlapping projections *H* are provided so that the plates cannot separate when subjected to pressure. M. W. W.

MILLING FIXTURE FOR THIN STOCK

About one hundred feet of rectangular-section steel rods was required for a set of models, the section of the steel being 0.088 by ⅞ inch. As this section was not available as a standard size, and as it was impossible to get so small a



A Simple Method of Milling Flat Stock

quantity rolled, it was decided to mill down ⅛ by ⅞-inch drawn steel, which was on hand, to the required size. This was done in a milling machine with the aid of the simple fixture shown in the accompanying engraving. In this illustration, *T* is a section of the milling machine table, through one of the T-slots *D*. The screw *S*, a standard stock part in the shop where this work was done, was provided with a handle *H* and a bearing *A*, which was also a stock part. This bearing was bolted to one of the other slots. The screw when so arranged operated a cast-iron nut *N* the entire length of the T-slot. Nut *N* was provided with a lip or shoulder rising 1/16 inch above the table for the purpose of driving the strip to be milled under the cutter. The lengths in which the flat steel rods were required were slightly less than the travel of the nut, which made this arrangement possible. Two clamps *C*, one of which is not shown, were placed at the front of, and behind, the cutter, and fastened so that the pieces to be milled would just slide under them as the work was being milled. By beveling the entering end of the strip to be

milled on top and feeding the piece lightly until it had reached under the second clamp, which held down the work on the side already milled, no trouble was experienced from the lifting up of the work. Had this occurred it would have been necessary to feed with the cutter. A spiral cutter with nicked teeth was used. Of course, the width of the slot in the milling machine table was less than the width of the strip. In this case the slot was 9/16 inch wide.

Middletown, N. Y. DONALD A. HAMPSON

A FIXTURE FOR SQUARE GRINDING

In the manufacture of high-grade automobiles, the square shaft is replacing the old-style feather key to a very considerable extent, especially in the transmission and heavy driving parts. There are also some parts of the motor in which the square hole and shaft has an advantage; one piece in particular is the valve push-rod, perhaps better known as the

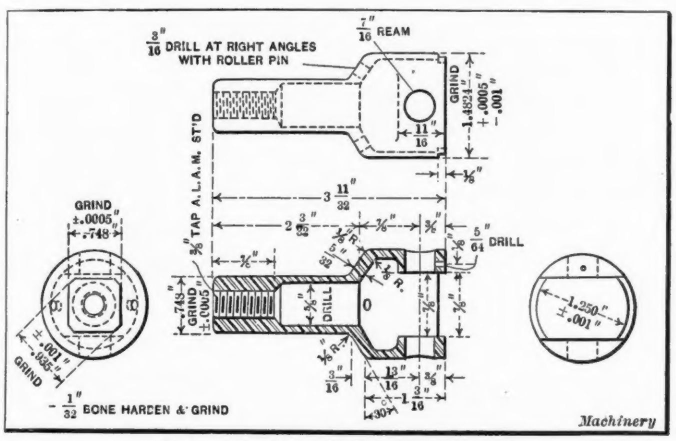


Fig. 1. The Valve Push-rod to be ground

valve tappet, shown in Fig. 1. This push-rod is made from machine steel, carbonized and hardened so that it is necessary to grind all of the working parts. The square part is 0.748 inch across the flats and has an allowable variation of only 0.0005 inch; this requirement, of course, necessitated the making of a very accurate fixture.

The first operation is that of grinding the large diameter, and rough grinding the corners of the square. This is accomplished in the usual manner, that is, by using a long center to enter the bottom of the hole of the large end and an ordinary center in the square end. The next operation is the grinding of the square body which must be perfectly concentric and parallel with the large diameter. The fixture for accomplishing this operation is shown in Fig. 2. It worked successfully, and was quickly and easily operated.

One of the greatest difficulties encountered in grinding fixtures, is that of preventing emery dust from collecting on the working parts, and considerable care was taken to design and make this fixture as nearly dust-proof as possible, regardless of the extra first cost. Another difficulty to overcome was the distance the tailstock was required to travel to allow the push-rod to be removed from the chuck. The size of the square also necessitated the making of a special tailstock, which will be described later. In designing this fixture, the question of future use, as well as that of accuracy and production, was considered. It frequently happens in the manufacture of automobiles that slight changes in the parts necessitate a complete new fixture unless some provision has previously been made. By making new collets, this fixture may be used for many purposes. The entire fixture was made as small and compact as possible. It has been the writer's experience that a neatly designed and well made fixture receives much better care in the hands of the ordinary workman than one that is poorly designed, unhandy and roughly made; and it is upon the care such tools receive that their continued accuracy and usefulness depends.

Referring to Fig. 2, the casting *A* is bored taper to receive the bronze bushing *B*, slotted through on one side to allow for adjustment, which is accomplished by lock-nuts *C* drawing the bushing *B* into the tapered hole in the casting. Spindle *D* has a very important function to fill—that of indexing—and is made from hardened and ground tool steel. To insure the greatest degree of accuracy, the indexing holes in the spindle must be protected from emery dust; consequently, they are placed under cover as much as possible, and are also protected by dust cap *E*, which is made from machine steel and fitted closely on the threaded portion of the spindle *D*. This cap is also closely fitted to the end of casting *A*, the latter having a groove cut in it to receive the felt washer *F*. In the forward end of cap *E* is another felt washer *G*, which in connection with the washer *F* makes it almost impossible for any dust to get into the bearing or indexing holes.

To retain the correct relation of the roller pin hole in the push-rod, Fig. 1, to the square body, the locating plug *H* is fitted into the bushing *I*, which is pressed firmly into the spindle *D* and passes through one side of cap *E* and chuck *J*. As this plug *H* is made to fit closely in the roller pin hole, Fig. 1, it is evident that the hole will be held in the correct relation to the square body.

The chuck *J* is of the ordinary spring collet type, keyed to the spindle *D*, and is operated by the handwheel *K* and draw-in bolt *L* which are held together by tapered pin *M*. Handwheel *K* is also used for indexing the spindle. The front end of the handwheel bears against spindle *D* so that when it is turned in the proper direction, it draws the chuck back into the spindle, thus closing it on the work. Felt washers *N* and *O* are inserted in the dust cap *P*, forming a perfect protection for the working parts in this end of the fixture. The indexing device is of the ordinary spring plunger type and is held in the boss *Q* on the casting. The indexing device consists

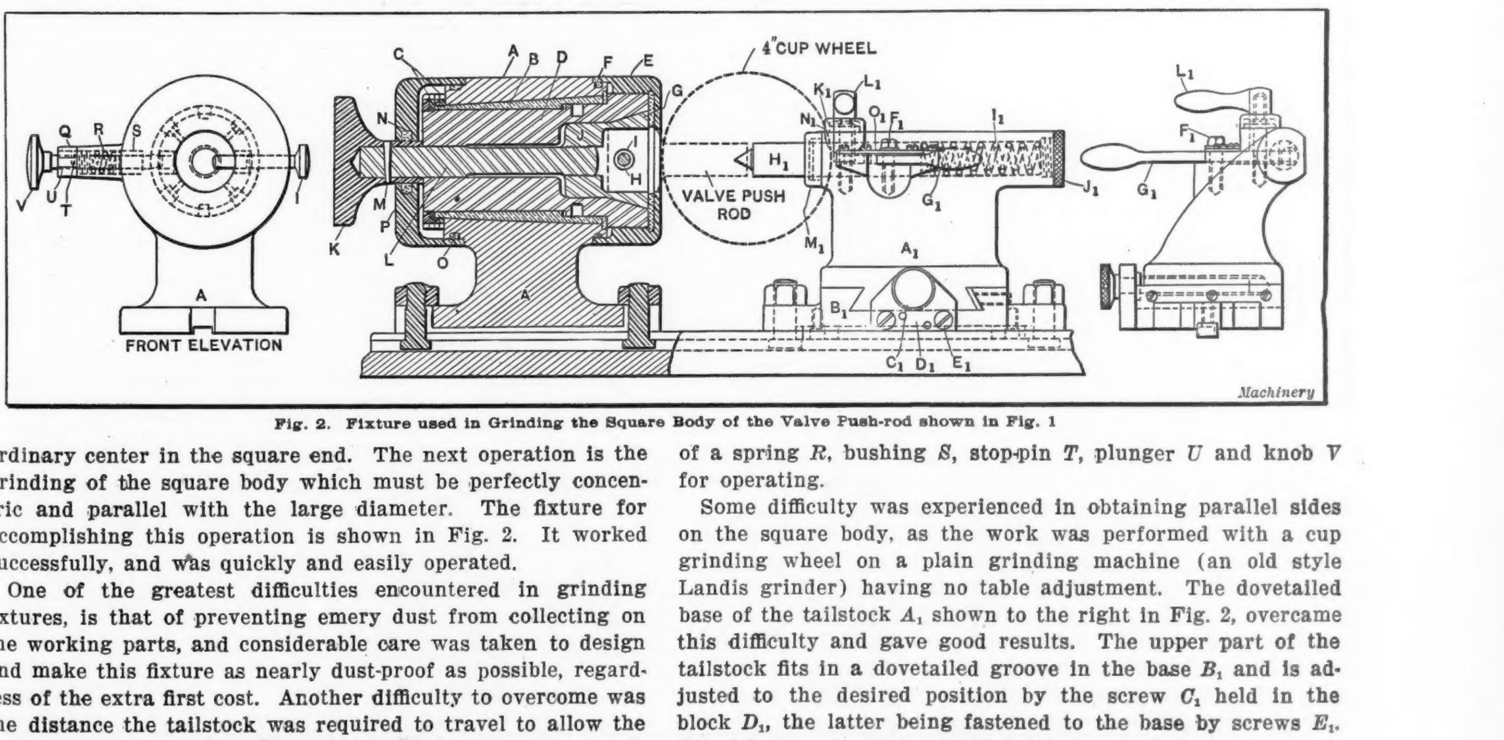


Fig. 2. Fixture used in Grinding the Square Body of the Valve Push-rod shown in Fig. 1

of a spring *R*, bushing *S*, stop-pin *T*, plunger *U* and knob *V* for operating.

Some difficulty was experienced in obtaining parallel sides on the square body, as the work was performed with a cup grinding wheel on a plain grinding machine (an old style Landis grinder) having no table adjustment. The dovetailed base of the tailstock A_1 shown to the right in Fig. 2, overcame this difficulty and gave good results. The upper part of the tailstock fits in a dovetailed groove in the base B_1 and is adjusted to the desired position by the screw C_1 held in the block D_1, the latter being fastened to the base by screws E_1. The fulcrum pin F_1 is placed in the lever G_1 in such a position that an angular movement of the lever of about 52 degrees gives a 1½-inch lateral travel of center H_1.

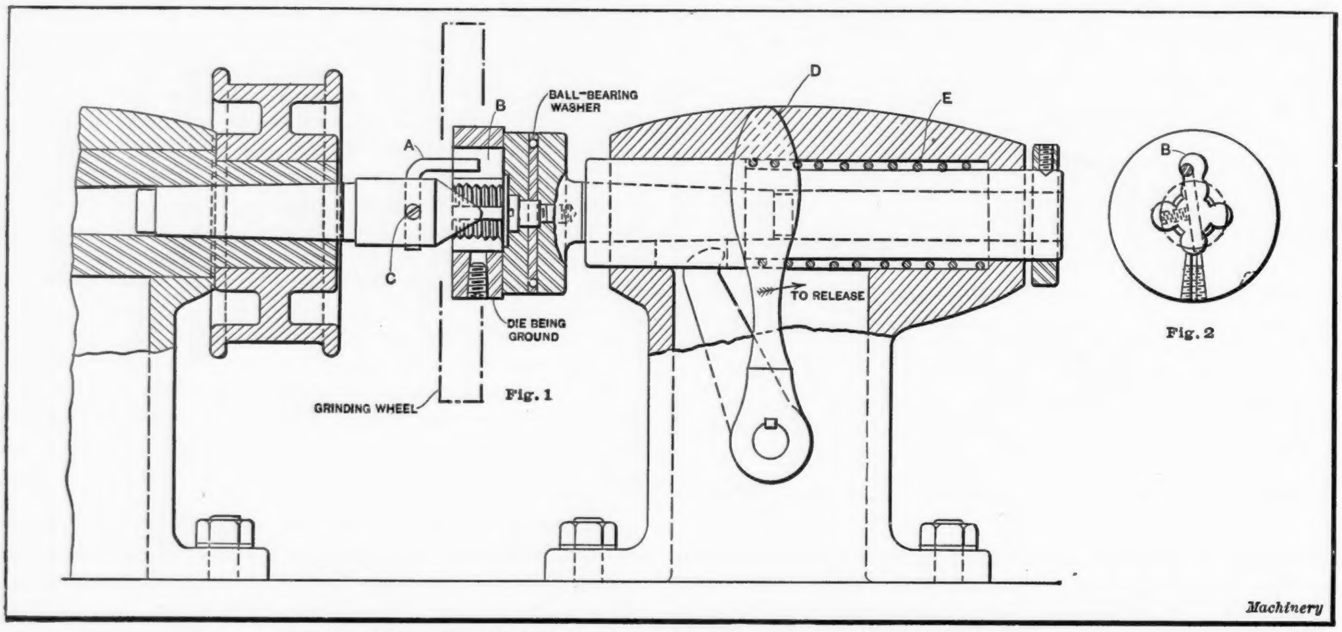
The tension spring I_1 is sufficiently stiong to keep the

proper pressure on the valve push-rod, and it is retained in the spindle by a cap-nut J_1. The center H_1 can be locked in any position by clamp-block K_1 and handle L_1. The dust-caps M_1 and N_1 and plate O_1 protect the working parts of the tail-stock spindle from dust. As the square body of the valve push-rod to be ground is 3/4 inch, it necessitated the flattening of one side of the center bearing in the casting, and also the off-setting of the center point on the movable center H_1. This fixture has been in use for two seasons, grinding about 50,000 push-rods with good results, and is still in good condition.

Lansing, Mich. E. H. Pratt

METHOD OF GRINDING THREADING DIES

The accompanying engraving shows a method which has been successfully used for grinding the outside of threading dies after hardening. Fig. 1 shows the arrangement with the die in position in the machine, while Fig. 2 shows an end view of the die, indicating how it is driven. The steel wire *A*, which is about 5/32 inch in diameter and bent so as to enter the hole *B* in the die, acts as a driving dog. It is held by set-screw *C* in the center.

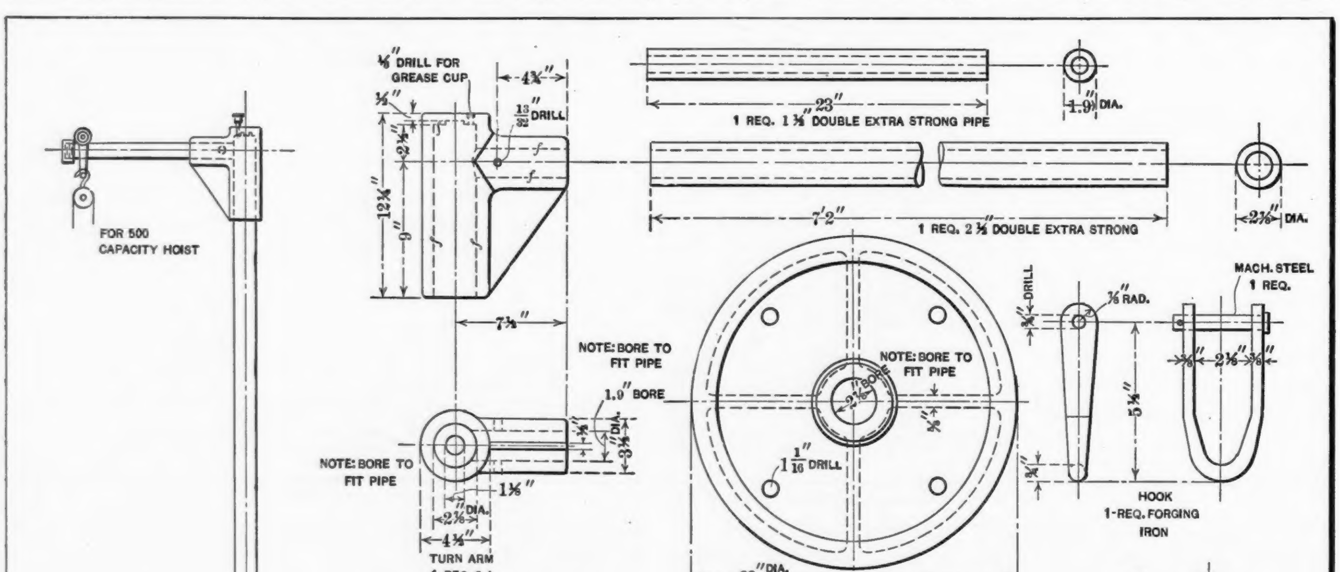


Figs. 1 and 2. Method of Grinding Threading Dies on the Outside after Hardening

When placing a die in the machine, the operator pulls the tailstock center by means of lever *D*, thus compressing the spring *E*. With his left hand he then places the die against the driving center and immediately releases lever *D*, allowing the tailstock pad or center to bear against the die by the action of the spring. The tailstock pad is provided with a ball-bearing washer to eliminate friction. The die is now held in position for grinding. Server

HOIST FOR LATHE CHUCKS, FACEPLATES AND HEAVY WORK

The accompanying illustration shows assembled and detail views of a handy and substantial hoist of cheap construction, which has been found convenient for handling heavy work, large chucks, faceplates, etc., on the lathe. It is bolted to the floor, back of a large lathe, or whatever machine it is used in connection with. It is especially valuable where it is impossible to use a portable or jib crane, and being of cheap but substantial construction, it can be used for a large range of work.



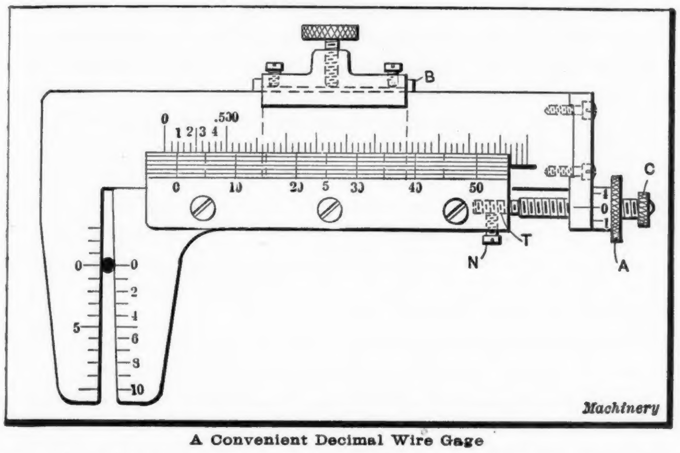
A Handy Hoist for Lifting Lathe Chucks, Faceplates, etc.

The hoist consists mainly of two castings, the base and the

bearing for the revolving arm. The upright and arm are of extra strong pipe, and the forged yoke with the steel roller completes the device. M. W. W.

VALUE OF A DECIMAL WIRE GAGE

The use of numbers in wire gage measurements may originally have been considered a convenience, but when another "number" gage differing from the original in the sizes designated by the numbers was added, the system became complicated. The basis of these different number gages is that each succeeding number designates a dimension differing by some fractional part of an inch from the preceding one, but each originator of a gage made the difference from each succeeding number different from the others, so that if we now compare the sizes and numbers of the different wire gages we find that no two are alike. There might, in former years, have appeared to be a reason for these different wire gages, with the numbered plates having slots corresponding to a letter or number designating the size of the wire, but since the micrometer and vernier scales have come into more common use, wire manufacturers generally prefer, when an order is given, to have the order specify the diameter of the wire in thousandths of an inch. Then why not discontinue the old gage numbers entirely?



A Convenient Decimal Wire Gage

In a catalogue before the writer, the standard wire gage of a large wire company gives No. 1 as 0.2830 inch; the same company's steel music wire gage No. 1 is 0.0156 inch. The B. & S. jewelers' wire gage No. 1 is 0.001 inch. Why should there be this difference in the designation of the sizes of wire? Whether the wire be brass wire, or music wire, or jewelers' wire, why should not the diameter corresponding to the given number be the same?

Now, why could not a new system be adopted in which, for example, No. 50 would mean 0.050 inch in diameter, and No. 200 would mean 0.200 inch in diameter? The B. & S. jewelers' wire gage is based on this system, and is the only practical system of wire gages in use. Many years ago, the writer made and sold a decimal wire gage to a number of manufacturing concerns based on this system of decimal identification number. This gage, as shown in the accompanying illustration, was adapted for measuring wire from the very smallest size up to 0.500 inch and was especially useful for inspecting wire in the stock-room. It was more easily used on wire than the ordinary micrometer and could be read to 0.00025 inch with accuracy.

This measuring instrument, as shown, has hardened taper jaws, the taper being such that the distance across at graduation 10 is 0.010 inch larger than that at 0; the gage bar is graduated as indicated, each graduation being 0.050 inch. A vernier scale is provided so that measurements as close as 0.010 inch can be read directly on this, and finally the graduations on the taper jaws give the dimensions in 0.001 inch; hence, it is possible to use this gage as graduated to measure wire of any size from 0 to 0.500 inch in diameter. The nut and screw at the right end of the gage are for the purpose of quickly and definitely locating the vernier at the reading required. The screw upon which the locating nut revolves has 20 threads per inch; thus one revolution of the nut agrees with one graduation on the bar.

Assume that it is required to set the gage to read 1/8 or 0.125 inch. First move the sliding jaw so that its zero line is opposite the second line from 0 on the bar, and from that reading continue to move the sliding jaw until 20 on the vernier scale coincides with the nearest line on the gage bar. The reading of the vernier, then, is the 0.120 inch. Now if we insert a piece of 1/8-inch wire between the taper of the measuring jaws we find that it will enter between the jaws until the graduation marked 5 is reached, the desired dimension being $0.120 + 0.005 = 0.125$ inch. Now if the piece inserted should only enter halfway between the 5 and 6 graduations on the jaws, it would be one-half of a thousandth inch too large. If it should enter as far as between the graduations 5 and 4, it would be one-half of a thousandth inch too small.

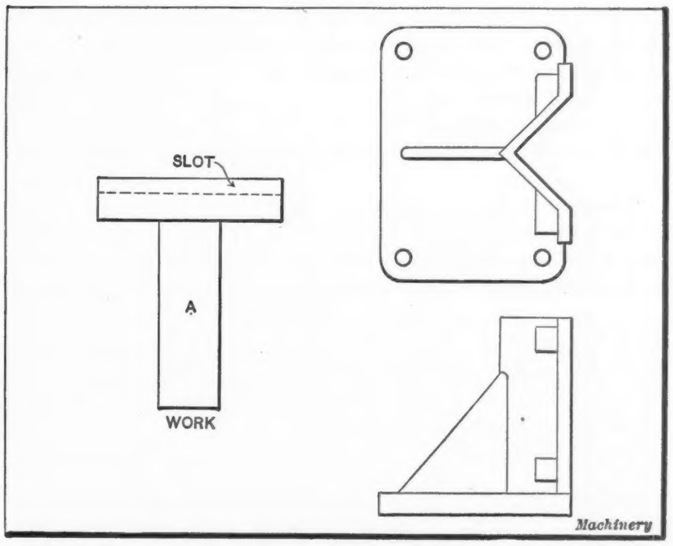
As another example, assume that we first set the zero of the sliding jaw opposite the three-tenths graduation on the bar, then move the vernier scale until line 15 coincides with the nearest graduation on the bar, and insert a wire that would enter between the jaws to the graduation corresponding to 7; the dimension of this wire would then be $0.300 + 0.015 + 0.007 = 0.322$ inch.

The adjusting nut *A* at the right end of the gage is graduated with five graduations. This makes it possible to set the vernier rapidly and accurately, as each graduation is equivalent to a 0.010-inch movement of the sliding jaw. The screw *C* on which the nut revolves is stationary and as there is a thread of different pitch at the end *T* of this screw, an accurate setting for the correct reading of the nut can be obtained. A set-screw *N* with a brass shoe at its end is employed to bind the adjusting screw in place. The gib *B* and gib screws on the top of the bar are to hold the sliding jaw tightly, so that it will move without lost motion. The set-screw on the top fastens the slide in the desired position.

Springfield, Mass. FRANCIS W. CLOUGH

MODIFIED FORM OF MILLING FIXTURE

The accompanying illustration shows a knee or angle plate which differs from the average type. Instead of having two flat faces as usual, this angle plate has one flat face, while the other is provided with a V-groove; wings are formed at the edges of the V, and these are planed off so that the knee can be placed with the V-side as a base, whenever flat work is to be clamped to the plain flat face. Lugs are cast upon these wings which are drilled for bolts for clamping purposes. An example of the work for which the fixture is adapted is shown at *A* in the illustration. Any part having a cylindrical stem and a slot, groove, or keyway cut across the end can be securely held in this plate while milling. Unless the work has a very long stem it can be done better and quicker by using this device than by gripping it in a vise and feeding in a vertical direction.



Modified Form of Angle Plate and Type of Work for which it is adapted

Middletown, N. Y. DONALD A. HAMPSON

SHOP RECEIPTS AND FORMULAS

A DEPARTMENT FOR USEFUL MIXTURES

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

HIGH-PRESSURE HYDRAULIC JOINTS

When oil is the fluid conveyed in a high-pressure hydraulic pipe line, glue makes an excellent material for applying to the threaded pipe connections, caps, etc. It will set and become hard very quickly. It is necessary to have the parts clean before the glue is applied.

Toronto, Canada. J. Cranford Smith

HARDENING SOLUTION FOR NOVO STEEL

The following receipt for hardening "Novo" and "Novo Superior" steel will be found useful: To one quart of kerosene oil add one pound of table salt, thus making a saturated solution. Heat the steel to a bright cherry red, rub cyanide of potassium on the parts to be hardened and heat again to a bright cherry red. Then dip the steel into the solution until cold.

Bristol, Conn. Irving E. Schubert

ENAMEL FOR INSULATED WIRE

The following is a satisfactory solution for coating wire with an enamel insulation. It consists of seven parts by weight of tri-acetyl-cellulose [C_6H_7 $(C_2H_3O)_3$ O_5]; ninety parts chloroform ($CHCl_3$); and three parts phenol (C_6H_5OH); thyme (a compact under shrub); and castor oil, added as a softener. This solution can be saponified, though not very easily, by a solution of potash. It can be more readily saponified, however, by the use of alcoholic potash. This enameling solution is much less inflammable than celluloid. It is colorless, but can be rendered visible by adding an aniline dye.

Pittsburg, Pa. H. M. Nichols

CEMENT FOR FILLING HOLES IN CAST IRON

The following is a good mixture for a cement for filling holes in cast iron, and may be well known to many: powdered cast iron, 40 parts; powdered sal-ammoniac, 1 part; powdered sulphur, ½ part. These ingredients are thoroughly mixed together and placed in an air-tight receptacle in a perfectly dry condition until wanted. When a hole in a casting is to be filled, take what appears to be the required quantity of the mixed powder, moisten it with water to the consistency of paste or putty, and fill the hole or depression, smoothing it up and allowing it to set.

When very deep depressions are to be filled, add to the above mixture an equal weight of fresh "vulcanite" Portland cement before dampening. After the water has been added, so that the mixture has the desired consistency, add non-volatile oil to the extent of 8 per cent by weight of the dry mixture used, and work the mass until the oil is fully emulsified; then apply the paste, finishing with a facing of the original mixture containing no Portland cement. This will produce a filler which will not shrink in setting.

St. Louis, Mo. C. H. Casebolt

OILS AND FATS AS HARDENING MEDIUMS FOR STEEL

Oils and fats produce, as a rule, less hardness in steel than does water. The hardness which they produce is usually accompanied by toughness. Thus such tools as are liable to crack in hardening, and where the greatest possible hardness is not required, are usually hardened in oil or fat. According to the *Metallarbeiter*, petroleum hardens more sharply than any other oil; then follows glycerine, which is too little known in this connection; then the lighter mineral oils; and at the foot of the list come the vegetable oils, as, for example, linseed oil. Among the fats, melted tallow and whale oil are the most used, the former giving a greater degree of hardness than the oils.

No matter what substance is used, however, one must not lose sight of the fact that there must be sufficient of it to permit the article being hardened to be moved quickly to and fro in the hardening medium, just as when water is used, so that the bath will not get hot. In most cases there is usually too little oil employed; the lack of success is then attributed to the use of the oil or fat, instead of to the fact that too little of it was used. R. G.

PRODUCING A BLUE COLOR ON NICKELED STEEL

By the use of the well-known bath of hyposulphite of soda and acetate of lead it is possible, by simply dipping, to produce a blue color on various metals. This is used for the purpose of producing an imitation steel finish on different metals. As is well known, the action is very satisfactory, and the articles thus treated look exactly as though they were made of steel that had been blued by annealing. Although this color can be produced on all metals, it is best brought out on nickel and nickel-plated articles. The brilliant white color of the nickel constitutes a good background for the thin blue coating; and for this reason the color is especially lively.

If this blue color is to be produced on unpolished nickel, it is recommended to color directly after plating, in order to prevent the surface getting spotted. With polished nickel, great care must be taken in cleaning. For this reason it is desirable to rub the nickel with rouge (crocus powder), as this can be readily removed from the metal and contains less mineral oil than "Vienna chalk."

For those who do not know the dip process thoroughly, it might be stated that the liquid for producing the blue color consists of 226 grams (8 ounces) each of sodium hyposulphite and lead acetate, and nine liters (8 quarts) of water. The solution is used boiling hot. The color is first yellow, then purple, and at last blue. When the right color is obtained, the articles are rinsed and dried, and then lacquered—otherwise the color will fade.

Dresden Germany. Robert Grimshaw

THE CHEAP BLACKENING OF BRASS

The following solution for blackening brass is nothing new; in fact, it has been known for a long time. Owing to its cheapness, ease in working and adaptability for many purposes, it has been deemed advisable to bring it again to notice, Many platers, of course, will recognize it as an old solution known to the plating industry for many years, but they may not have realized its advantages for some classes of work. The solution is made as follows:

Water	1 gallon
Sugar of lead	8 ounces
Hyposulphite of soda	8 ounces

The solution is used as hot as possible and the brass work, is simply dipped in it and allowed to remain until black. This takes about a minute or less. The articles are then rinsed in cold water, then in hot water and dried. If scratch-brushed dry, the black deposit will have a high luster.

When dipped into the solution, the surface of the brass article becomes yellow, then blue and finally black. The article should not be taken out until all the surface has become blackened. The deposit on it is sulphide of lead. The articles should always be lacquered as the black deposit is likely to oxidize and fade if not; but if coated with lacquer, it seems to be quite permanent.

For a cheap class of goods that require a black finish, this solution can frequently be used to a good advantage. It requires no electric current, being used as a dip. The color, to be sure, is not coal black, but resembles a graphite black more than anything else and has a slight gray shade. It is sufficiently black, however, to answer many purposes and it is so easily applied that it can be used on cheap goods with only a slight increase in cost.—*Brass World.*

* * *

Always provide some means for holding bolts from turning while the nuts are being screwed on, if a wrench cannot be used on the head of a bolt.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

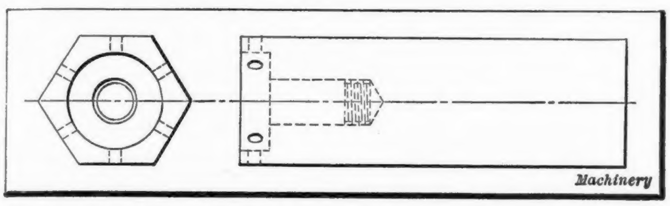
MARKING ON BLUEPRINTS

The most simple and at the same time probably the most effective method of marking on blueprints is to use a common soap-stone pencil, similar to those used in machine shops and tool-rooms. The end of the pencil should be ground to a sharp point on an emery wheel. Lines and letters made in this manner cannot be distinguished, when first made, from those originally on the blueprint, and will stand an almost indefinite amount of wear before becoming obliterated.

Indianapolis, Ind. F. B. Hays

A SIMPLE DRILL JIG

On a number of special capstan-head screws, six holes were to be drilled, as indicated by the illustration, which shows the jig used for the drilling operation. This jig was made from a piece of hexagon steel rod. Instead of tapping out

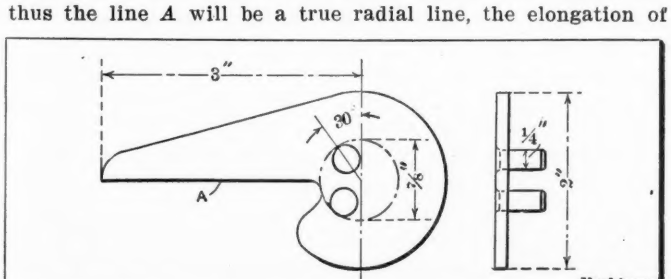


the full length of the hole for the screw, only a few threads were cut at the bottom, which saved time in handling the product to be drilled. In this instance the heads of the screws extended far enough out of the jig so that they could be turned by hand. This jig was casehardened and has proved itself good for long service. Jigs of this type are quickly made, and the cost is so small that even for experimental work it often pays to make such a jig.

Middletown, N. Y. Donald A. Hampson

MILLING CUTTER TOOTH TESTING GAGE

The gage shown in the accompanying illustration is intended for testing the radial direction of the faces of formed milling cutters, especially gear tooth cutters. The two pins shown bear on the inner side of the hole in the cutter, and thus the line *A* will be a true radial line, the elongation of



which passes through the cutter center. Gear cutters should be tested, from time to time, with this gage to make sure that the faces of the teeth are in a radial direction, as, otherwise, the shape of the gear tooth being cut will not be an exact duplicate of the original gear cutter form. J. S. B.

REPAIRING LATHE CHUCK SCREWS

The square heads of chuck-jaw screws sometimes become so badly worn that their keys will no longer fit them, and it becomes difficult to use the chuck. To order a new screw sometimes means quite a delay. The writer has used the following method successfully: Remove the jaw, take out the screw and heat it to a cherry red; then, with a few sharp blows, upset the square end of the screw until it is large enough to file to its original size; take care not to injure the threads of the screw during this operation. Then file the head of the screw to fit the chuck key. After hardening, the screw is as good as new. W. H. Addis

Lafayette, Ind.

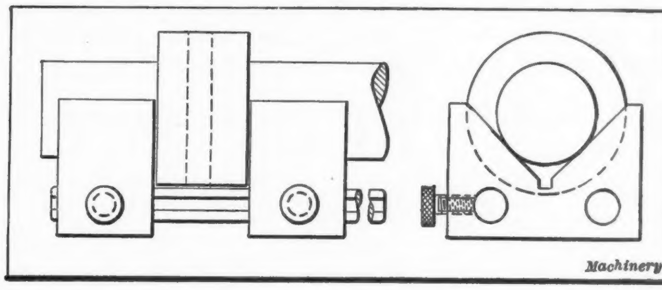
LATHE FILE HANDLES

The writer generally saves all ends cut off from new belts and cuts them up into pieces, about 1¼ inch square, into which he drills a hole, about No. 40, ⅝ inch deep. These pieces are used by the tool- and die-makers when they want a handle for a small file. Usually they drive a piece of leather onto the file tang and then shape it to suit their requirements. The toolmakers prefer these to wooden handles.

St. Louis, Mo. James S. Glew

CONNECTED V-BLOCKS

The accompanying illustration shows two uniform V-blocks which are connected so as to be used as one unit. Blocks so

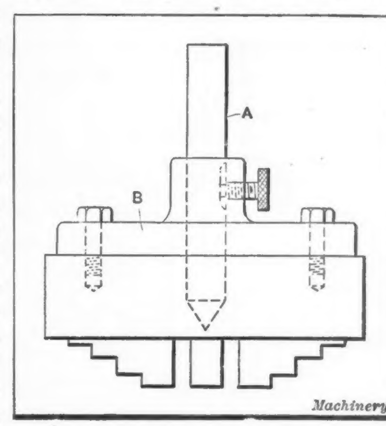


connected are handy for work of the kind shown in the illustration; in fact, they form a very effective jig, or rather jig replacer.

Manchester, England Francis W. Shaw

AN ACCURATE CENTER PUNCH

The writer had a number of different sizes of rods to center, and to do this work quickly, a center punch was made from a three-jaw universal chuck, as shown in the illustration. A faceplate *B* was made and bolted to the back of the chuck, for carrying the punch *A*. In one side of the center punch a flat was milled for the end of a screw which prevented the punch from dropping out. The chuck was set over the end of the shaft, and the jaws were tightened with a chuck wrench, and then the punch struck with a hammer. This method of centering was very quick and accurate.



Superior, Neb. J. N. Bagley

CUTTING COARSE INTERNAL THREADS IN THE LATHE

In cutting coarse internal threads with a cutter held in a bar which is clamped rigidly in a fixture fastened in the T-slot of the compound rest, it is impossible to have the cutter cut one side of the thread at a time. To accomplish this result, engage the split nut on the lead-screw to the full capacity of its engagement for a few cuts; then engage the nut a little less than full, holding it there by the hand so that the carriage will lag a little behind the previous cut. Continue doing this for a few cuts, and then engage the split nut to its full capacity, and so on. Lead-screws which are provided with an Acme thread allow the accomplishment of this "trick" without any trouble.

It might be considered bad practice to only partially engage the split nut, because of the uneven wear on the nut and screw, but this does not seem objectionable to me, as the engagement is so nearly full that the consequent wear is very slight. In the general run of shop work, nuts having a coarse thread to be cut are the exception rather than the rule, so that this kink would not be frequently employed.

Los Angeles, Cal. John A. Wood

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

CAVEATS NOT GRANTED BY PATENT OFFICE

F. A. G.—Are caveats no longer granted by the United States Patent Office?

A.—Section 4902 R. S., authorizing the filing of caveats for inventions was repealed by act of Congress June 25, 1910, the new law taking effect July 1, 1910. Since this date there has been no provision of law for the filing of a caveat in the United States Patent Office, and it is no longer permissible for an applicant to file a caveat for the purpose of obtaining further time in which to mature his invention.

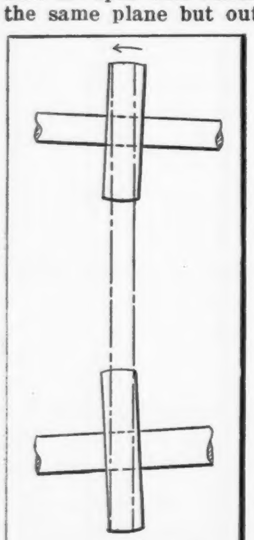
ALLOWABLE SHAFT DEFLECTION FOR GEARING

D. E. W. Co.—In calculating the size of shafts carrying gears how much should be allowed as the maximum permissible deflection? We are unable to find anything printed on this subject that is at all satisfactory and we are therefore appealing to you. Any information that you can give us on this subject will be very much appreciated.

A.—None of the available authorities specifies the allowable shaft deflections for gearing. The general rule is to mount all gears close to the bearings so as to minimize the bending moment, and most designers apparently proceed on the assumption that the deflections are negligible when the shafts are sufficiently strong to stand the torsional stresses and the gears are mounted close to the bearings. Data from practice followed when gears are not set closely to the bearings is requested.

WHY BELTS RUN TO THE HIGH SIDE OF PULLEYS

T. J. C.—It is common experience noted by all mechanics that an open belt running over pulleys mounted on shafts in the same plane but out of parallel, runs to the "high side." Why is this so?



Illustrating the Tendency of Belts to run to the High Side of Pulleys

A.—A belt runs to the high side of the pulleys because of the direction of motion of the parts of the belt between them. As the free part of the belt winds onto the leading side it tends to follow the same line of motion around the pulley face, and if the shafts are out of parallel the belt path becomes at first a helix which if continued would run off the pulley on the high side. The illustration of an exaggerated case shows the belt leading to the left or high side of the pulleys, the edges of the belt being projected in a straight line to emphasize the drift to the side. When the pulleys are crowned, the crowning counteracts the tendency of the belt to run off unless the shafts are badly out. The crown of the pulleys, by the way, acts in the same manner on both sides of the belt when the shafts are parallel. Both sides of the belt crowd toward the center which is the highest part of the pulleys, and it is thus that crowning prevents belts running off the pulleys.

SOLUTION OF A TRIANGLE

F. B.—In the triangle shown in the accompanying illustration, angle A and side b are known. It is also known that the length of side a is to the length of side c, as 10 is to 8. What is a simple method for solving this problem? I have looked for a solution in various textbooks in vain.

A.—The sides of a triangle are to each other as the sines of the angles opposite the respective sides. Hence, in the triangle shown,

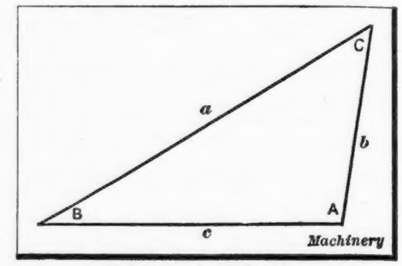
$$\frac{\sin A}{\sin C} = \frac{a}{c}$$

From this we get

$$\sin C = \frac{c \sin A}{a}$$

but, as

$$\frac{a}{c} = \frac{10}{8}, \text{ we have } \frac{c}{a} = 0.8$$



Solution of a Triangle

and, therefore, $0.8 \times \sin A = \sin C$. The angle A being known, angle C is thus determined, and the triangle is solved in the same manner as any triangle in which one side and the angles are known. (See MACHINERY's Reference Book No. 54, "The Solution of Triangles," page 49.)

* * *

METALS USED FOR STEAM TURBINE BLADES

In an article in *La Technique moderne*, M. P. Breuil deals with the metals used in the construction of steam turbine blades, the data given referring to continental European practice. In the Zoelly turbine, blades made from 5 per cent nickel steel are used, while Harlé & Cie. prefer steel with 32 per cent nickel. The advantage of this steel, however, might be considered doubtful, as Rateau has found steel with 25 per cent nickel unsuitable for turbine blades. The opinions of French manufacturers of special steels differ widely as to the contents of nickel. It does not seem as if the influence that nickel has on metal used for turbine blades has been fully investigated, and there is considerable uncertainty as to the behavior of the metal in a turbine blade. The bronzes, as well as the monel metal, which are used for turbine blades by some of the manufacturers, soften considerably at temperatures above 570 degrees F., and have a relatively low elastic limit, but they have the advantage of being but little affected by corrosion.

Attention is further called to the fact that on the side of the admission of steam the first blades work in high temperatures, with dry steam at great velocity; the blades further back are subject to lower temperatures and lower velocities of steam, but the steam is wet, and there is, besides, the friction of metal particles carried away by the steam. The guide blades are stationary, and are not subject to the action of centrifugal forces like the rotor blades. It appears, therefore, that different metals ought to be used for each of these three classes of blades, but in all cases the metal used must possess great resistance to chemical and mechanical corrosion, and be easily machined by ordinary shop processes.

As to the chemical corrosion of metals by hot steam there are practically no reliable data. From investigations of the action of salt water on metals it would appear that aluminum and manganese bronzes and monel metal would give good results, but it is quite possible that chemical corrosion is altogether very slight as compared with physical, and the material used ought to be chosen on the basis of resistance to the latter, with respect to which nickel steel appears to have very high qualities, with its breaking strength of 80,000 pounds per square inch, elastic limit of 57,000 pounds per square inch, hardness (Brinell) of 180, and elongation of 20 to 22 per cent. It is, moreover, naturally hard, not brittle, and comparatively cheap. There are no data as to its probable behavior at high temperatures, but having a low percentage of nickel it would probably behave like other steel, and would reach the minimum of its elastic limit and elongation at about 570 degrees F., without, however, becoming brittle. The firm of Wickers Maxim makes turbine blades of laminated bars with a steel core and nickel surface, the nickel layer being extremely thin.

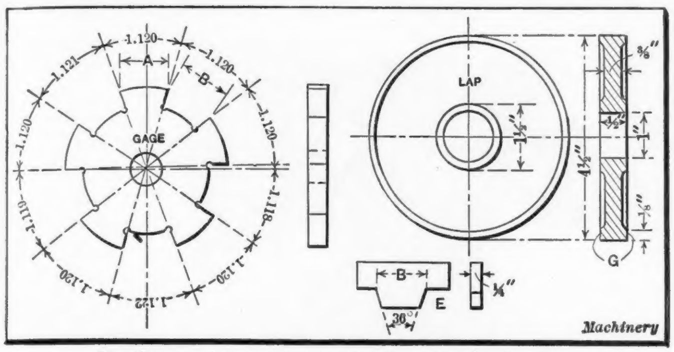
* * *

As an example of the importance of having the walls of shops and factories painted in light colors in order to increase the light in the workroom, it may be of interest to note that in one case where the intensity of the illumination in a saw-tooth roof building was 9.7 foot-candles in the center of the building, it was 13.5 foot-candles at a distance of three feet from the whitewashed walls, showing an increase of nearly 50 per cent due to reflected light from the walls.

MAKING A HUB CLUTCH GAGE

BY J. M. HENRY

In the following article is described a successful method for making a hub clutch gage of the type illustrated in the accompanying engraving. The first difficulty met with is that of distortion in hardening, which, however, may be overcome by using "Ketos" or "Paragon" oil-hardening steels, in which case it is possible to machine the gage to within 0.002 inch of the finish size, and finish it by lapping. For the lapping, a disk lap is used, and the operation is performed in a milling ma-



The Gage to be lapped, the Disk Lap, and the Templet

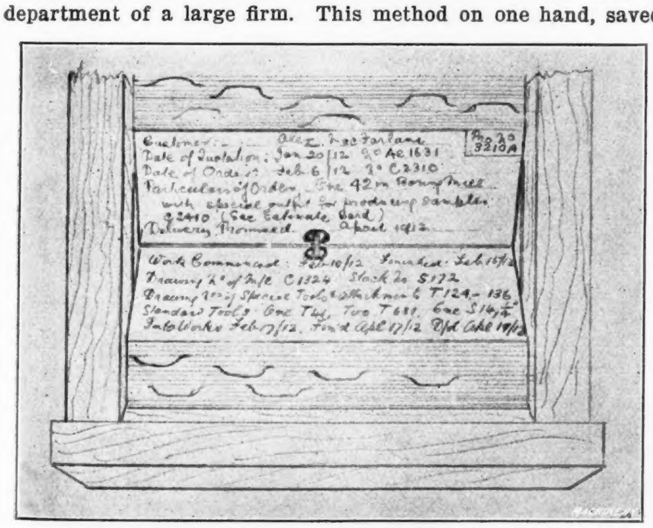
chine. The disk lap is turned as shown in the engraving, and placed on an arbor in the milling machine. It is trued up on the sides G to insure its running parallel with the ways so as to be completely in contact with the work. The gage is then mounted on the index centers and one side of the lap is set central with it. The blank is indexed around until it just touches the lap, a sounder being used to determine when this takes place. The lap is now charged with emery and oil, the machine is started, and the gage rapidly passed by the lap a number of times. After having lapped the first surface, the gage is indexed around to the next lug and the operation repeated, thus continuing around the gage until having lapped one side of the lugs. The opposite side of the lap disk is then set central with the gage, and the gage indexed around the opposite way until the other side of one of the lugs touches the lap, after which the lapping is continued until the dimension A is correct on all the lugs. A templet E is used, from time to time, to test the accuracy of the spacing.

* * *

UTILIZING BOTH SIDES OF INDEX CARDS

BY CARD INDEX

The accompanying illustration shows how both sides of the cards used in a card index were utilized in the tool-designing department of a large firm. This method on one hand, saved



Card Index, in which Both Sides of the Cards are utilized

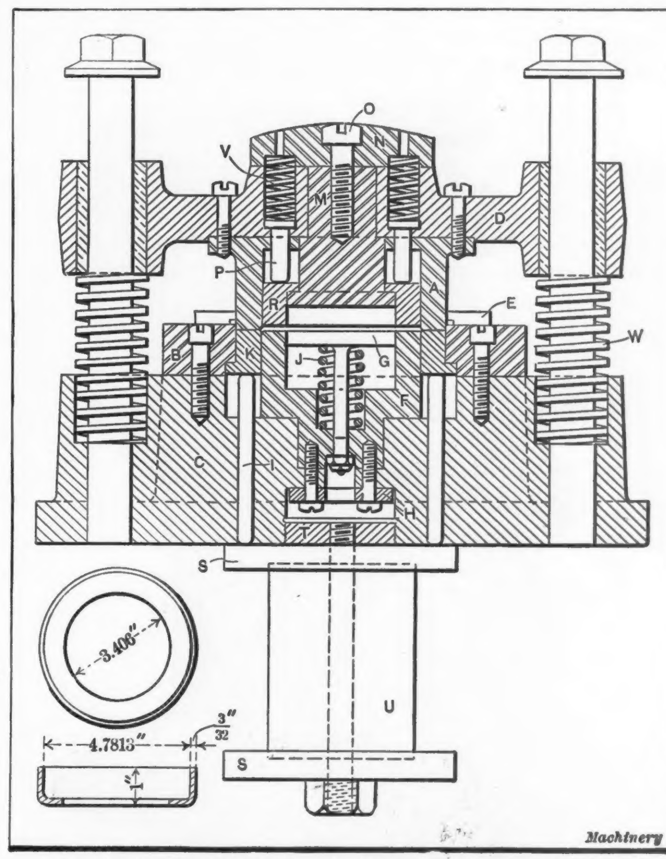
extra cards, and on the other, made it possible to record all the necessary information relating to each item on one card. On the back of the card the information was entered upside down so that when the cards were pressed towards the front of the drawer, the information entered could be easily read. In the engraving two separate cards are shown for convenience, but it is understood, of course, that all the information pertaining to one subject is entered on the two sides of the same card.

A COMBINATION DIE

BY A. J. DUDLEY

The shell shown in the lower left-hand corner of the accompanying engraving is a retainer for the ball races of an automobile clutch. This retainer is a sheet-metal stamping made in a powerful trimming press having a 5-inch stroke. The style of die used is a combination die which produces the shell complete in one operation within the limits of tolerance required—0.001 inch for all dimensions except for the height of the shell. The blank for the shell is approximately 6⅝ inches in diameter. The material is hot-rolled steel, 3/32 inch gage, fed into the die in the form of a strip.

In the illustration, A is the blanking punch and drawing die, made of tool steel, hardened and ground; B is the blanking die which is secured to a cast-iron die-block C. A stripper E is secured to die B by screws (not shown). The drawing punch, and die for the center hole in the shell, is shown at F, and the retaining plate for this punch at H. Punch F is also made of tool steel, hardened and ground. A knockout G, op-



A Combination Blanking and Drawing Die and Work for which it is used

erated by a helical spring J, ejects the waste center blank. Some difficulties were first experienced with this knockout owing to the sticking of the blank, but this was overcome by placing a small knob in the center of the knockout (and a corresponding recess in the face of punch M) which deflected the blank enough to prevent it from sticking. Punch M does not operate until nearly at the end of the stroke. At K is shown the shell stripper which also acts as the spring pressure pad during the drawing operation. This is supported by four pins I resting upon the flange S. A powerful rubber spring U effects the stripping of the finished shell from punch F.

Another pressure pad and stripper is provided at R. It is supported by pins P and helical springs V and bottoms on the inside flanges of punch A. The buffer plate N acts as a retainer for punch M and is provided with vent holes to release the air pressure produced by pins P and pad R. Heavy square helical springs W open the die after each stroke, the rubber spring U assisting in this operation during part of the stroke.

Owing to the limited height available between the bolster plates of the press, it was impossible to use an adapter—hence, the necessity for spring operation. The die has worked successfully for several months, but it has been found necessary to lubricate it copiously when in operation.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

COCHRANE-BLY UNIVERSAL SHAPER

Diemakers and toolmakers are often obliged to use a number of machines for making a die or jig, especially if the shape is at all complicated or irregular. This means that the work must be reset in each machine, which not only requires extra time but often makes it difficult to secure accuracy between the different surfaces, thereby increasing, in many instances, the amount of hand work necessary for fitting and finishing. The Cochrane-Bly Co., of Rochester, N. Y., is now manufacturing a universal machine that has been designed to perform quite a variety of operations at one setting of the work; therefore it is especially adapted to the making of dies, jigs or to general tool-room work. This machine is known as a universal shaper, but, in reality, it is a shaper, slotter, milling and drilling machine combined.

Fig. 1 shows a view of the right-hand side and Fig. 2 the left-hand side with the circular table in position. This machine consists principally of a column supporting the knee and table, a shaper ram, a milling and drilling spindle, and suitable speed- and feed-changing mechanisms. The milling spindle and shaper ram have universal adjustments so that tools can be presented to the work at any desired angle. Fig. 4 shows the heads in a vertical position drilling a die, and Fig. 3 shows the shaper ram set in a horizontal position.

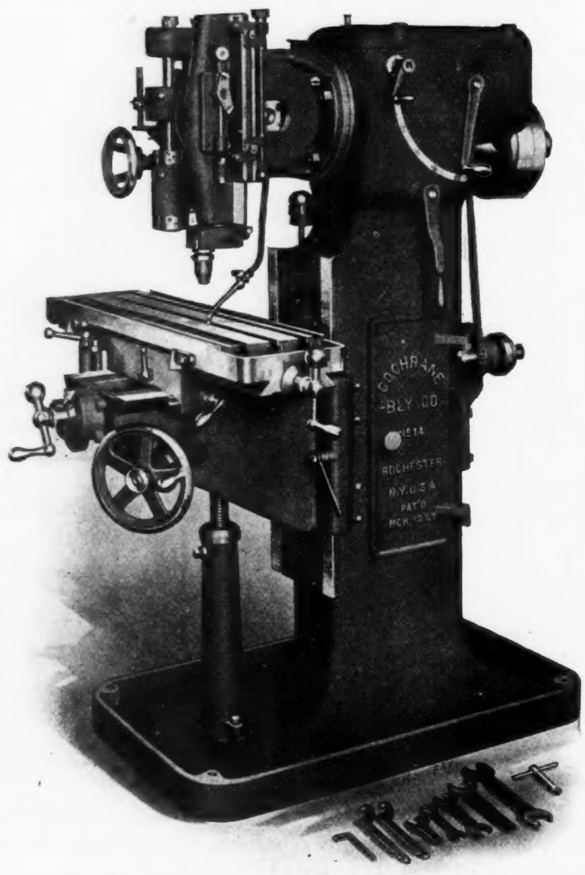


Fig. 1. Combined Universal Shaper and Milling Machine for Die, Jig and General Tool Work

The drive is from a constant-speed clutch pulley at the rear; this transmits the power through a double cone of spur gears to the main head, which carries bevel gears for driving both the shaper ram and milling spindles. The cones of spur gears provide means for varying the speeds, and their arrangement is shown by the sectional view, Fig. 5. The speed changes are effected by means of a driving key *A* which is shifted into engagement with any one of the five upper gears, thus giving five speed changes for the shaper ram and milling spindle. The position of this key is controlled by the large lever seen in Fig. 1 near the top of the column. The end of this lever swings around a graduated quadrant which shows the number of ram strokes per minute for any one of the five positions. The key in the gear cone, as well as the gears and shafts, is hardened, and all bearings are provided with bushings. The clutch pulley, when idle, runs on roller bearings, and the clutch is engaged or disengaged by the vertical lever seen at the side of the column in Fig. 1.

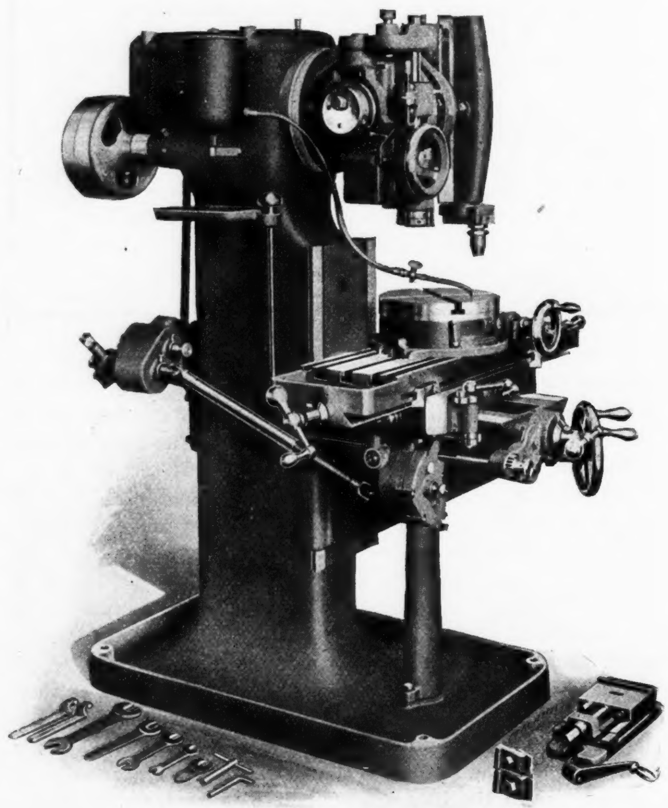


Fig. 2. Universal Shaper equipped with Circular Table Attachment

The main head has a bearing in the column and is locked in position by three bolts which engage a circular T-slot. The entire head, including the shaper ram and milling spindle, can be revolved about a horizontal axis (after loosening the clamping bolts) by turning a small crank which is located at the upper end of the graduated quadrant previously referred to (Fig. 1). This crank operates the worm *B*, Fig. 5, which,

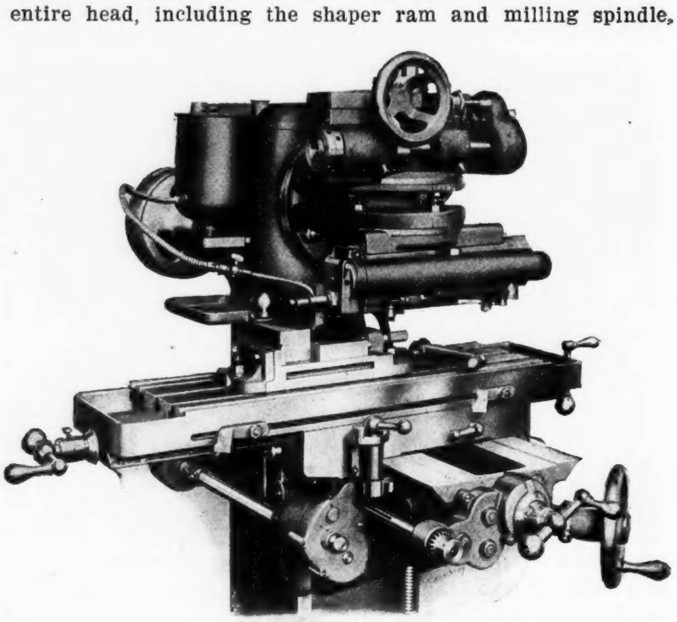


Fig. 3. Shaper Ram set in a Horizontal Position

in turn, engages a worm-wheel attached to the inner end of the main head. The shaper and milling heads each have an independent adjustment about an axis at right angles to the main head, which makes it possible to locate them at any angle. All three heads have large circular bases which are graduated to degrees.

The milling spindle is driven by bevel and spur gears from the main head and runs either right or left. It has a slide movement of 3½ inches for drilling and boring, which is controlled by a handwheel operating through worm-gearing. A micrometer screw-stop, reading to thousandths of an inch, is provided to facilitate accurate adjustments. The spindle is fitted with taper bronze bushings and adjusting collars to take up wear.

The shaper ram is driven through bevel gears and a crank-and-link mechanism. It has a quick return and the stroke can be adjusted from zero to six inches. The tool-head of the ram swivels and can be set to work at any angle. The ram is equipped with a mechanism (illustrated in Fig. 6) which provides a positive relief for the tool on the upward or return stroke. The clapper is held firmly against the tool-head during the cutting stroke by means of a knuckle-joint mechanism, and it is released at the end of the stroke by a relief dog, which strikes the lower roll or tappet shown in the illustration. The clapper remains in the released position on the return stroke and it is thrown into the working position again when the dog engages the upper roll. These rolls are adjusted for any length of stroke by means of a right- and left-hand screw which is turned by a knurled knob at the top.

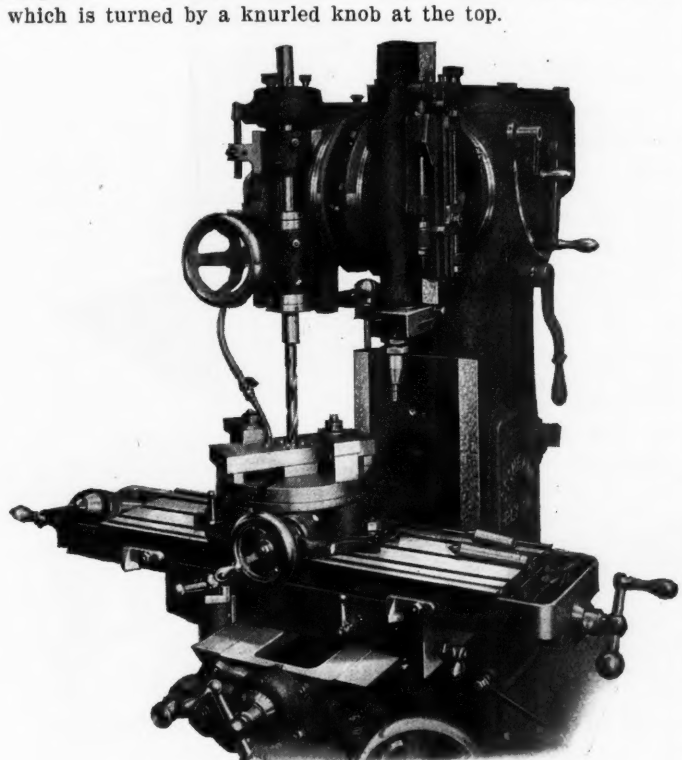


Fig. 4. Drilling a Die with Milling Spindle

Power feed is provided for the longitudinal and transverse movements of the table and also for the circular table, if desired. The feeding motion is derived from a sprocket *C*, Fig. 5, which is connected by a silent chain with the feed-box, seen at the rear in Fig. 2. From this point the motion is transmitted to the front of the machine by a universally jointed, telescoping shaft in the usual manner. When the milling spindle is being used, the feed is continuous, whereas an intermittent feed, which takes place on the return stroke, is required for the shaper ram. Either a continuous or intermittent feed is obtained from the rear feed-box, which is shown in detail in Fig. 7. For a continuous feed, the drive is through spur gears, and for an intermittent feed, a crank-and-ratchet mechanism is brought into action, provision being made for disengaging either the gear or crank mechanisms.

Tool-holders for various styles of shaping tools are interchangeable in the tool-head. Three forms of tool-holders are illustrated in Fig. 8, which also shows a set of standard slotting tools such as are carried in stock by this company. The slotter tool-holder *A* takes all shapes of slotting tools having 3/8-inch square or 7/16-inch round shanks, and it is used when shaping out small dies, for broaching and for cutting

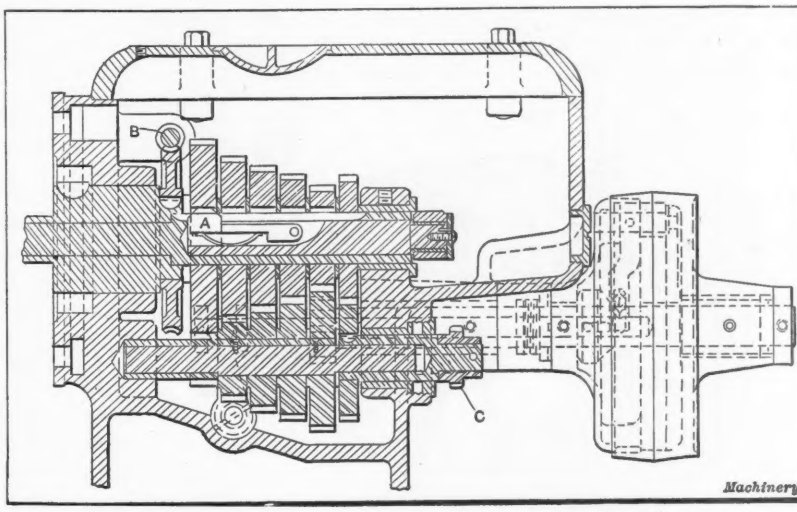


Fig. 5. The Constant-speed Clutch Pulley and Speed-changing Mechanism

internal keyways, etc. The shaper toolpost *B* holds lathe or shaper tools of ½-inch or ¾-inch size, and is used when the machine is working either as a horizontal shaper (as shown in Fig. 3) or as a vertical shaper. The extension holder *C* takes ⅜-inch square bits and can be used for inside or outside shaping operations.

The table of this machine has a working surface of 28 by 9 inches and there are three ⅝-inch T-slots for clamps. The feed-screws are accurately cut and are provided with ball thrust bearings. There are also compensating nuts for taking up wear and large graduated dials reading to thousandths of an inch. The saddle has a bearing on the knee 12 inches wide, and provides a way 18¼ inches long for the table. Both of these slides are fitted with taper gibs. The saddle carries the feed mechanism and the feed-control handle is mounted at the front. The knee has a bearing 10 inches wide and 13½ inches long on the column, and is fitted with an adjustable gib and locking screws. The thrust on the elevating screw is taken by a ball bearing. The circular table is 12 inches in diameter and is furnished with or without power feed. It is graduated in degrees and is revolved by a handwheel, the dial of which reads to five minutes. Provision has a made for disengaging the worm-gear, when it is desirable to revolve the table quickly by hand. The column is cast in one piece and has sufficient metal to absorb all vibration. The head of the column containing the driving and speed-changing gears, forms an oil-tight box so that these gears run in a bath of oil.

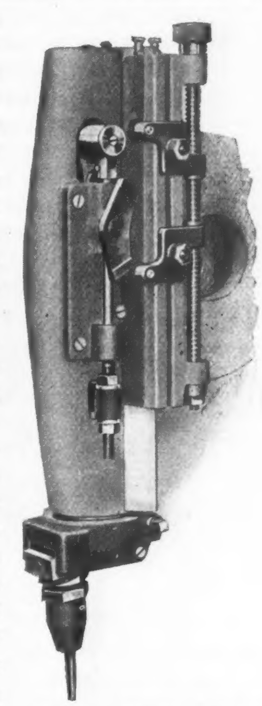


Fig. 6. Detail View of Shaper Ram showing Relief Mechanism

The machine has been designed throughout to provide convenient operation, all control levers being within reach of the operator from the front of the machine. The durability of the construction has also received careful consideration, the spindles, shafts and driving gears being hardened and all bearings bushed. While this machine was designed to be accurate and sensitive on fine work, the driving mechanism is sufficiently powerful to permit taking heavy cuts for removing stock rapidly.

Some of the principal dimensions of this machine are as follows: Longitudinal travel of the table, 22 inches; transverse movement, 10 inches; vertical adjustment, 18 inches; angular adjustment of the main head, 360 degrees; maximum stroke of shaper ram, 6 inches; maximum distance from end of ram to table, 15 inches; number of speeds, five; number of strokes per minute, from 25 to 150; angular adjustment, 30 degrees each way from the center; maximum distance from end of milling spindle to table, 16 inches; maximum distance from center of spindle to face of column, 13½ inches; number of taper, No. 9 B. & S.; size of hole through spindle, 17/32 inch; angular adjustment, 45 degrees each way from the center; number of speed changes, five; variation, from 55 to 330 revolutions per minute; micrometer stop adjustment, 3½ inches. The shaper ram has an intermittent feed varying from 0.002 to 0.032 inch per stroke, and the milling spindle has six feed changes varying from 0.004 to 0.048 inch per revolution. The net weight of the machine is 2000 pounds; the height over all, 65 inches.

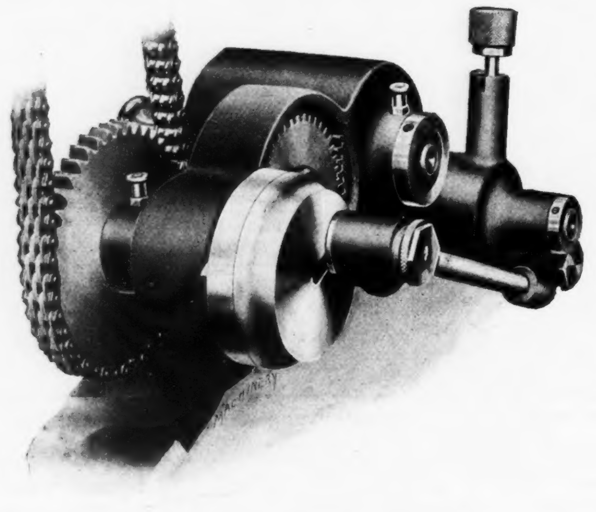


Fig. 7. Mechanism for Obtaining Continuous Feed for Milling and Intermittent Feed for Slotting

The equipment includes an oil tank and hose; shaper, slotter and extension tool-holders; a spud-bar for the milling spindle; a set of slotter tools; wrenches, etc. The following extra equipment can also be furnished, if desired: A circular table with or without power feed; a milling machine vise; draw-rods for the milling spindle; spring collet with bushing and nut; drill chuck; expanding milling arbors; milling machine center; center for circular table; sleeves for the spindle, and a self-contained motor drive.

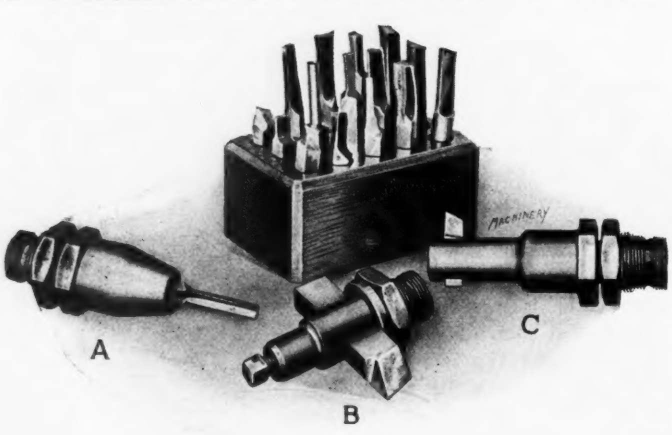


Fig. 8. Set of Slotting Tools and Different Tool-holders

The full universal features of this machine, in conjunction with the various tools which can be used, make it possible to machine a large variety of such work as blanking and forging dies; punches; forming tools, such as are used in turret lathes, automatic machines, etc.; jigs, especially when shaping, milling and boring operations are required; and similar classes of work. While the machine was designed more particularly for the tool-room, the universal features make it possible to handle with the regular equipment and standard tools, a large variety of wōrk which ordinarily would require several machines of different types and also special tools and fixtures.

NEW SQUARE CAN DOUBLE SEAMER

A new automatic double seamer has recently been designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for square, oval and oblong work and will seam cans ranging from ¾ inch to 5½ inches in height. The rate of production depends somewhat on the size of the can, and the expertness of the operator, and varies from 12,000 to 20,000 ends in ten hours.

The machine is driven by an automatic friction clutch encased in the two-step driving cone. A hand brake arranged on the end of the driving shaft, automatically engages and releases after the work is done and insures stopping the spindle in exactly the same position after every cycle. By referring to the accompanying illustration, it will be noted that the lower spindle drive is positive, the lower spindle starting and stopping in unison with the upper spindle. This insures a perfectly straight body after double seaming.

Bliss Automatic Double Seamer

All movements are automatic so that the operator has nothing to do but place the can on the chuck and depress the treadle. This causes the lower spind'e to rise and engages the clutch, thus starting the driving shaft which is connected to the chuck spindle by bevel gears, and bringing the double seaming rolls into action. The can is automatically revolved the required number of times, and the double seamer rolls, after going through their motions, are automatically retired, the clutch is automatically disengaged, the chuck is stopped, the lower plate is dropped and the can released. The weight of the machine is 1100 pounds.

STANDARD MACHINERY CO.'S PRESSES

The press shown in the accompanying views represents a new line that has just been brought out by the Standard Machinery Co., 7 Beverly St., Providence, R. I. The particular machine illustrated has a net weight of 13,500 pounds. It is heavily back-geared with cut steel gearing, and is equipped with this company's instantaneous roller friction-clutch. This clutch allows the machine to run continuously or to be automatically stopped after each revolution either by hand or foot. The clutch grips the instant the treadle or handle is depressed, instead of allowing the flywheel to turn from one-half to a full revolution before coming into engagement. After engagement, there is less than 1/32 inch travel on the periphery of the balance wheel. Another noteworthy feature of the clutch is that it enables the press to be stopped at more than one point in a revolution. Most of the clutches applied to these presses are made to stop on the up stroke and down stroke, which adapts the machines for heavy forming, embossing or

similar operations in connection with which it is essential to have the dies dwell after striking.

This machine is extra heavy and rigid in design. It is fitted with stay-rods and is of the open-side and open-back type. The construction of the upper and lower connections as well as the adjusting and clamping device is worthy of note. The lower connection consists of a forged steel ball fitted into a hemispherical center in the ram. On the upper part of this ball there is a bronze retainer which is also hemispherical on the lower part. The upper part of the lower connection is threaded and fits into the upper connection. The clamping is effected by the four screws shown in the upper connection. This connection is split through the center and each of the screws passes through to the opposite side. Around each screw there is a bronze bushing. These bushings and the holes in the upper connections are threaded, and in order to clamp the upper connection to the lower, after the ram is adjusted to the proper height, the screws are tightened and the bronze bushings, which are fitted to the threads of the lower connection, are forced against the shank of the lower connection. This gives a positive grip which will not slip. The bronze bushings around the clamping screws prevent the lower connection from being marred or bruised. The upper connection is bronze-bushed around the wrist-pin and the latter is five inches in diameter.

The boxes of the main bearings can be adjusted for wear and the press is arranged, on the left side of the crankshaft,

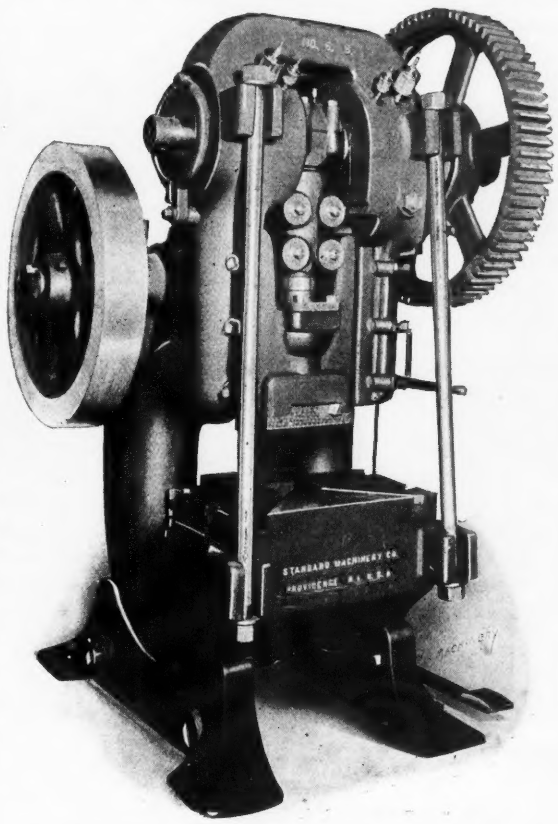


Fig. 1. Heavy Back-geared Press built by Standard Machinery Co

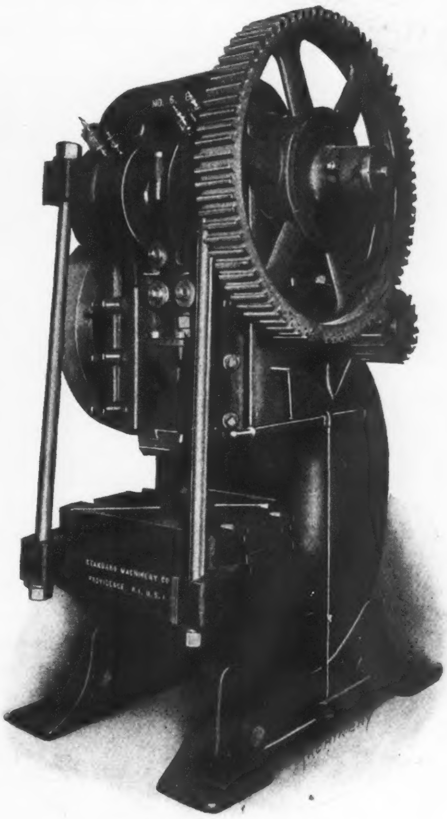
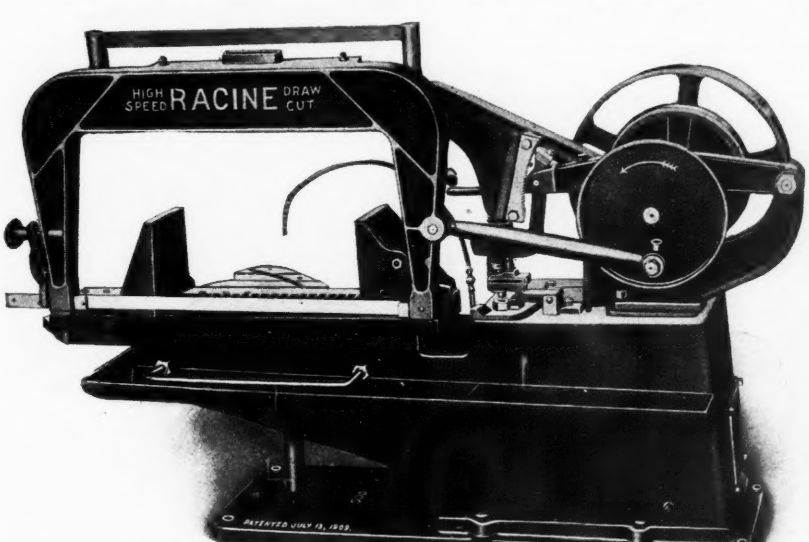


Fig. 2. Another View of Standard Press



Racine Twelve-inch Metal-cutting Machine

to permit the attachment of a roll or dial feed. The bolster plate is fitted with T-slots so that die-holders and dies of various sizes can be attached. The hole in the bed is generally made to specifications. The boxes for the back-gear shaft are bronze lined and have large oil grooves. The pinion is of cut steel and the driving or clutch gear is made of special "gun iron." The machines are equipped with a tight-and-loose pulley drive in addition to the balance wheel, when so specified. The main frame is liberally proportioned to endure all kinds of shocks incident to cutting and embossing operations. This particular line of presses is not only made single back-geared but double back-geared and either plain or motor driven.

The weight of the press is 13,500 pounds and the weight of the flywheel, 900 pounds. The gear ratio is 1 to 4½. The stroke of the press is 3 inches; diameter of the crankpin, 5 inches; adjustment of the slide, 6½ inches; distance from the slide to the bolster plate, with the stroke down and adjustment up, 7 inches; distance between the uprights, 16 inches; width of bed from front to back, 18 inches; width from right to left, 30½ inches; and the overall height, 8 feet 6 inches.

RACINE METAL-CUTTING MACHINE

The Racine Tool & Machine Co., Racine Junction, Wis., has brought out a new 12-inch metal cutting machine. This machine, which is illustrated herewith, is intended for machine shops, steel warehouses, structural steel works, etc., and is designed to do rapid and accurate work. It will cut 6-inch round machinery steel in 20 minutes and 12-inch I-beams in 10 minutes. The capacity is given as 0 to 12 inches, although the machine can be furnished to take stock measuring 12 to 15 inches. The blades used can vary in length from 17 to 24 inches.

The blade is lifted clear of the work on the return stroke by means of an automatic device. This prevents the blade from dragging on the non-cutting stroke, thereby greatly increasing the life of the blade and the output of the machine. There is a quick-acting vise which swivels to an angle of 45 degrees and can be adjusted so that the entire length of the blade can be used. With a 24-inch blade, stock measuring 11 to 12 inches can be cut at an angle of 45 degrees. The blade holders are made from a 1- by ⅜-inch flat bar fitted into a

milled slot which holds the blade secure with the work. There is also a blade tightener which enables the operator to vary the tension without using a wrench. A cutting compound is supplied to the blade by a geared, circulating pump. The saw frame automatically holds itself at any height, which is very convenient when placing stock in the machine. When the machine is cutting to its full capacity, only about ⅔ horsepower is required for driving.

CINCINNATI FRICTION-DRIVEN SWIVEL-HEAD LATHE

The latest development of the Cincinnati Precision Lathe Co., Fosdick Bldg., Cincinnati, Ohio, is a bench lathe equipped with a swivel-head which can be located at any angle with relation to the ways of the bed. This machine, a general view of which is shown in Fig. 1, has a friction drive similar to the one employed on this company's precision bench lathe which was illustrated in the department of New Machinery and Tools for May, 1912. The swivel-head has angular graduations on the base for setting it in any required position, and it is securely held by an eccentric bolt at the left end and a hardened bolt at the front or right end. The position of the head is accurately maintained by a hardened and ground circular ring inserted in the upper base and fitting closely in a circular slot in a plate that is bolted to the lathe bed. This swivel-head, in conjunction with a combination external and internal toolpost grinder and a double swivel slide-rest, makes the machine a universal precision grinder and lathe.

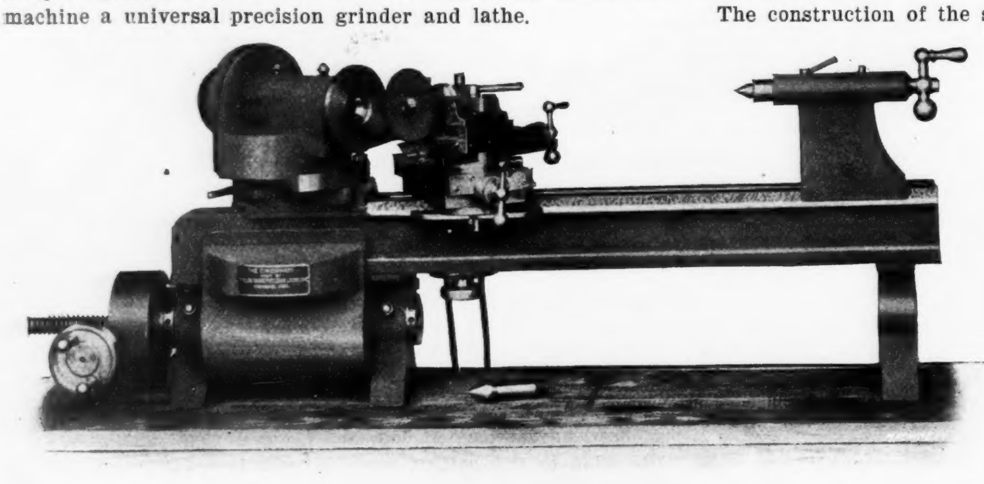


Fig. 1. Swivel-head Lathe arranged for Face Grinding

Fig. 1 shows the position of the headstock and slide-rest for face grinding. The head is set at an angle of 30 degrees, and each swivel rest is also set to the 30-degree position, thus giving a total angle of 90 degrees. Fig. 2 shows the machine arranged for angular grinding, the operation in this case being that of truing the lathe center. Fig. 3 is a rear view of a lathe equipped with a standard head and serves to show

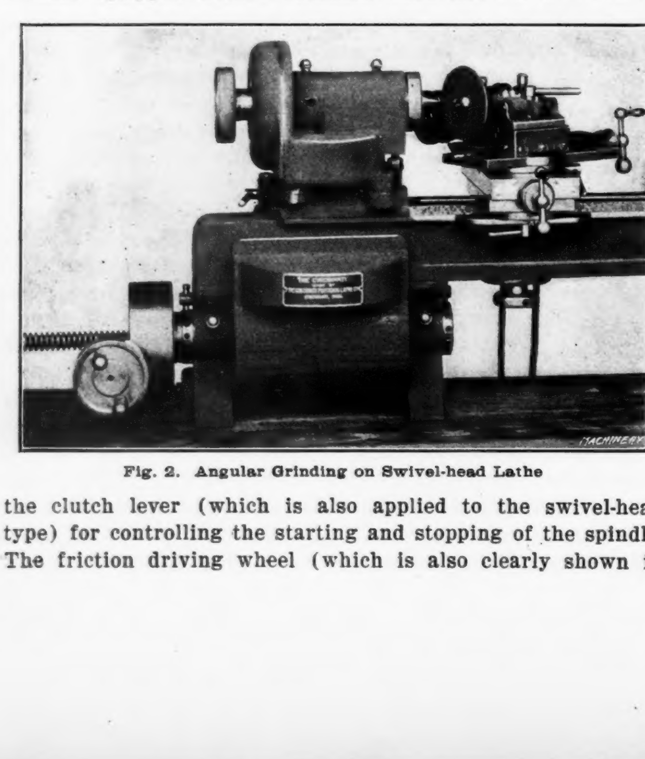


Fig. 2. Angular Grinding on Swivel-head Lathe

the clutch lever (which is also applied to the swivel-head type) for controlling the starting and stopping of the spindle. The friction driving wheel (which is also clearly shown in this view) is first located on the horizontal driven disk for the required speed, as shown by a speed indicator on the outer edge of the hand adjusting wheel. The main spindle can then be engaged instantly for operating at this speed, by a downward pressure on the clutch lever previously referred to, whereas an upward movement of this lever disengages the

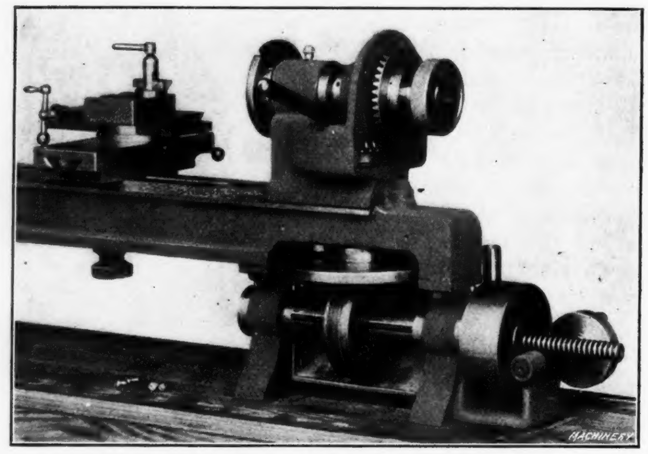


Fig. 3. Rear View of Lathe having Standard Head

spindle. The application of this device makes a countershaft unnecessary for operating the lathe. For the operation of a grinder, a combination countershaft for the lathe and grinder is employed.

The construction of the spindle control clutch is shown by the sectional view, Fig. 4. There is a hardened taper member *A* which, when raised by lever *B*, forces four hardened pins outward against a split ring *C*, thus bringing the latter into engagement with the miter gear *D*. As soon as this engagement takes place, all the working parts of the clutch are revolved with the gear and vertical driving spindle in the center. This engagement is effected with a very slight pressure on the hand lever and the weight of the lever is balanced by a small spring as shown, which causes the inner or forked end to "float" in the circular lifting slot, thus eliminating friction and wear.

The split ring *C* is slightly under size in its released position so that there is no friction at this point when the clutch

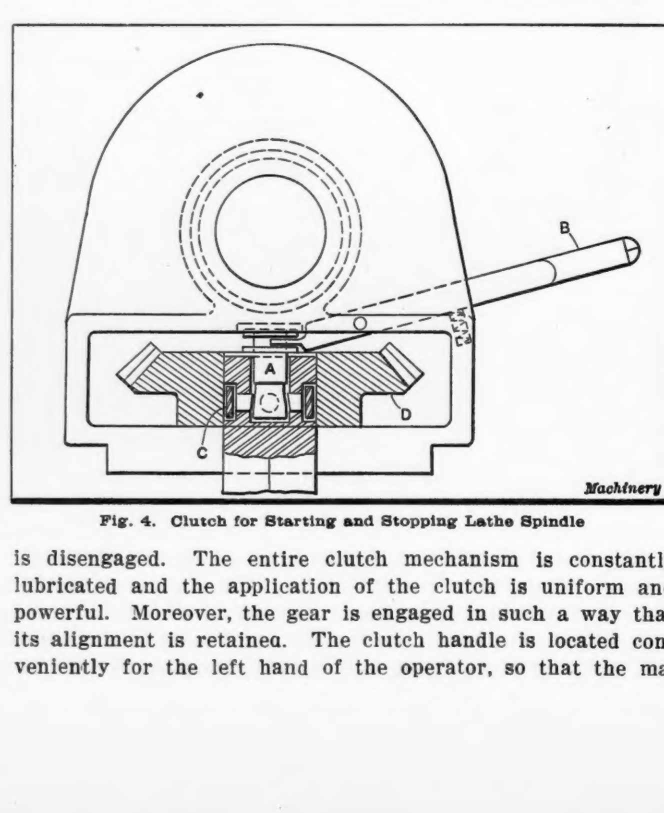


Fig. 4. Clutch for Starting and Stopping Lathe Spindle

is disengaged. The entire clutch mechanism is constantly lubricated and the application of the clutch is uniform and powerful. Moreover, the gear is engaged in such a way that its alignment is retained. The clutch handle is located conveniently for the left hand of the operator, so that the ma-

chine can be stopped and started easily and quickly. Provision has also been made for starting and stopping, independently of the driving belt, by placing the friction driving disk into a slight depression in the center of the horizontal driven disk. When the driving disk is in this position, the entire machine is stationary, excepting the driving friction shaft which, in this case, acts as a self-contained countershaft.

This friction drive eliminates a cone pulley and permits spindle bearings that are practically continuous. The direction of rotation is easily reversed, and wear between the friction members is taken up by means of eccentric bushings which enable the driving shaft to be raised or lowered parallel with the face of the driven disk. The location of the belt pulley makes it possible to apply power from beneath the bench, as well as from the side or overhead. The grinder can also be driven from beneath the bench, if desired. This lathe has a swing of 8 inches; a 32-inch bed; and a maximum distance of 15 inches between the centers. With the constant-speed driving pulley revolving at 1000 revolutions per minute, speeds ranging from 850 to 2500 revolutions per minute are availaole.

AJAX RECLAIMING ROLLS

The reclaiming rolls illustrated in Fig. 1 were designed for re-rolling scrap iron and steel, in order to reclaim the large amount of material which is thrown on the scrap pile and sold at scrap prices. The waste represented by the scrap heap is a very important item on railroads, but by means of these rolls, all discarded parts, such as truss rods, arch bars, draw-

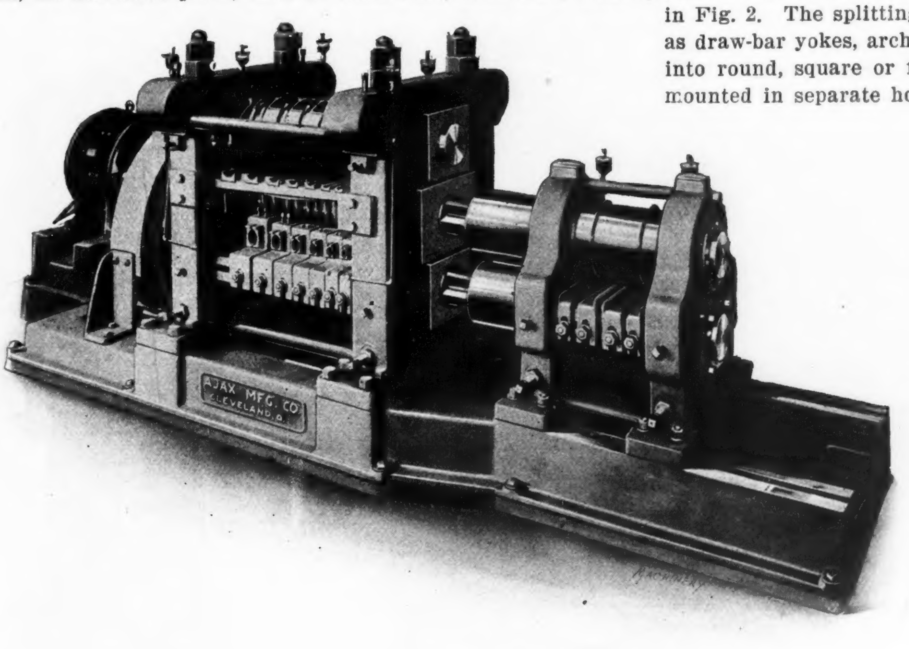


Fig. 1. Ajax Reclaiming Rolls for Re-rolling Round, Square or Flat Bars from Scrap Iron or Steel

bars, center pins, etc., can be reclaimed by heating and re-rolling them into round or flat stock from which bolts, car fittings or similar parts can be made. These reclaiming rolls are built by the Ajax Mfg. Co., Cleveland, Ohio.

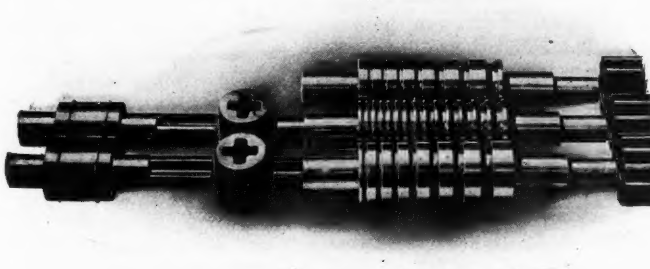


Fig. 2. The Three Reducing Rolls and the Splitting Rolls for Splitting Flat Stock Longitudinally preparatory to Re-rolling

The machine shown in Fig. 1 is a "three-roll-high" type and is provided with an auxiliary or secondary set of rolls for splitting flat stock longitudinally preparatory to re-rolling it in the main reducing rolls. The scrap bars are ordinarily cut into lengths varying from two to five feet. The length depends upon the section, and is decreased as the size of the bar increases. These bars are heated in suitable furnaces and are then started through the rolls. The first pass reduces the bar to an elliptical shape and it is then rolled round on the return pass. This process is repeated until the stock is reduced to the required size.

The rolls used in this machine are turned from forged steel

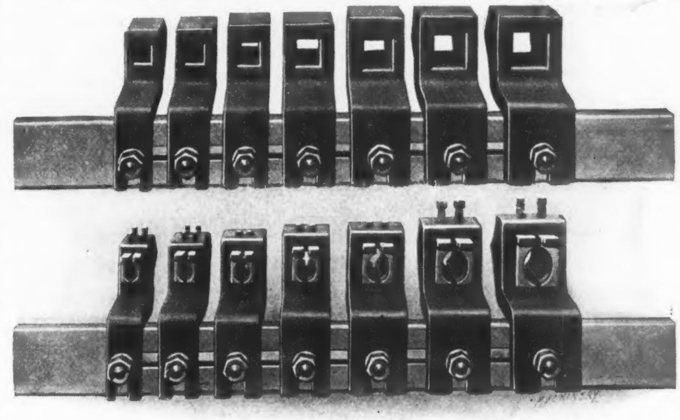


Fig. 3. The "In-and-Out" Guides for Round Stock

of special analysis and are mounted in phosphor-bronze bushed bearings. A set of three main reducing rolls for rounds, and a pair of splitting rolls with the crab connection, are shown in Fig. 2. The splitting rolls shear lengthwise such flat stock as draw-bar yokes, arch bars, etc., and thus facilitate re-rolling into round, square or flat stock. These two sets of rolls are mounted in separate housings, as shown in Fig. 1. The yoke over each of the main housings insures ample strength and rigidity. The smaller housings are seated on T-slot ways so that the splitting rolls can easily be removed. The baseplate of the machine is cast in one piece. Two sets of main reducing rolls are furnished, one being for rounds and one for squares or flats, as may be specified. The solid bearings of the main rolls can be adjusted vertically by means of double wedges. The main housings have bronze adjusting pieces which are located against the sides of the bearings and provide lateral adjustment for the main rolls. These bronze pieces are slightly tapered and adjustment is effected by shifting them in or out.

The main reducing rolls are 12 inches in diameter and 40 inches long between the housings and are grooved to reduce 2-inch rounds from 1¾ inch down to ½ inch, inclusive. The range of the main rolls for producing flats depends upon the nature of the scrap, although an idea of the capacity can be obtained from the foregoing figures. A steel channel or trough should be provided back of the machine for receiving the bars when they finally leave the rolls. Against the side of this channel the bars are straightened and allowed to cool.

The machine is equipped with suitable "in-and-out" guides for either round or flat stock. Fig. 3 illustrates sets of in-and-out guides for round stock. The first pass is through an "in" guide (see upper view) between the upper and middle roll, and the bar, rolled to an elliptical shape, comes out through an "out" guide. The bar is then returned through an "in" guide (see lower view) between the bottom and middle roll and comes out round. This process is repeated until the stock is reduced to size. The main rolls have a peripheral speed of approximately 300 feet per minute.

Ample heating capacity should be provided for heating the scrap stock, and two furnaces are recommended, one being a heating chamber for bars up to four feet long and the other for bars up to eight feet long. These furnaces should be

placed in front of the rolls and at right angles. The production of these rolls varies according to the nature and size of the scrap bars and the size to which the bars are re-rolled. The heating furnace equipment also affects the production so that it is difficult to give an accurate estimate. The average production, however, ranges from six to eight tons in ten hours, and the fuel cost averages about $6.00. The operating crew consists of from four to five men, including a roller and assistant roller, a heater, a helper and a man to carry the re-rolled bars to the cooling and straightening tables. The power required to operate the rolls, when driving by belt from a lineshaft, will range from 20 to 40 horsepower, whereas if a direct-connected motor drive is employed a 50-horsepower motor is recommended.

BEAUDRY POWER HAMMER

Beaudry & Co., Inc., 141 Milk St., Boston, Mass., have brought out a new design of power hammer. This new hammer is applicable to general forging work and it is especially adapted for plating and drawing steel, or for use in the manufacture of cutlery, edge tools, files, agricultural implements, spindle and general toolmaking or any forging operations requiring an extremely quick blow. The hammer can be operated at a high rate of speed and is designed for continuous service.

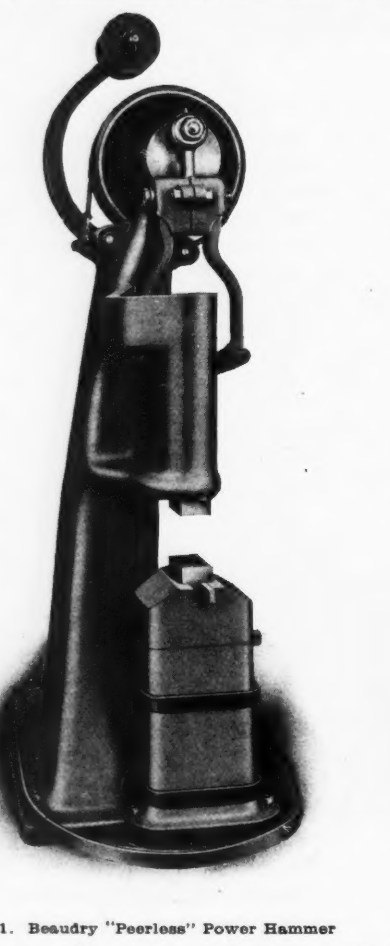


Fig. 1. Beaudry "Peerless" Power Hammer

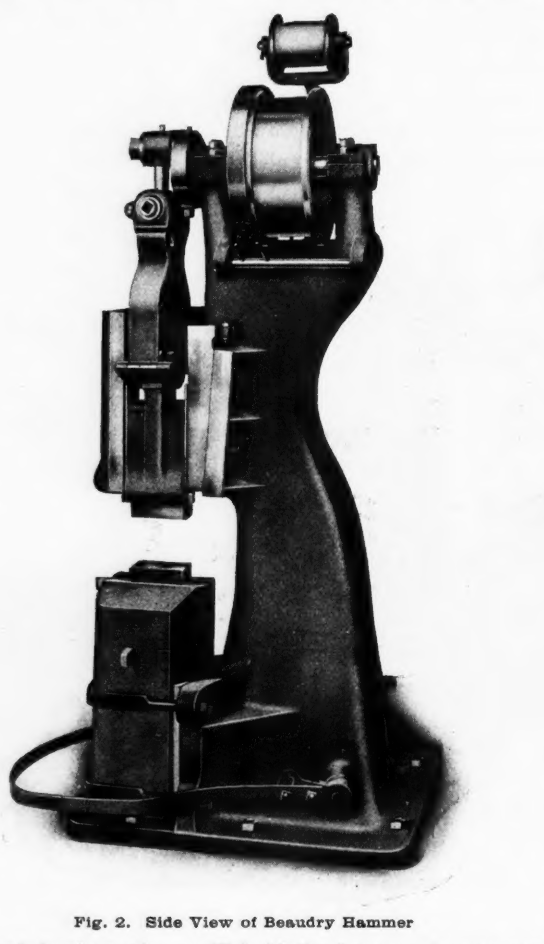


Fig. 2. Side View of Beaudry Hammer

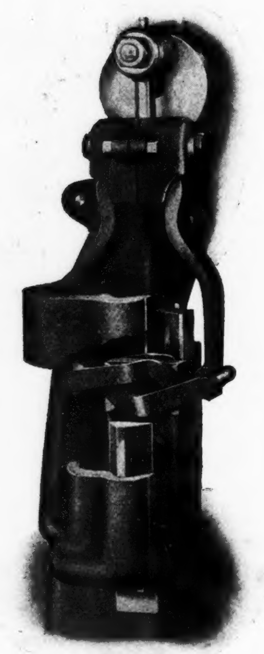


Fig. 3. Sectional View of Hammer

Front and side views of this hammer are shown in Figs. 1 and 2. The ram is connected by means of spring arms and two long steel links which are arranged to occupy a minimum space and, at the same time, give a maximum freedom and lift of the ram, as well as an elastic and cushioned but powerful blow. The tension on the spring arms and links is maintained and adjusted by means of tension nuts in a spring box. These working parts are clearly shown in the sectional view, Fig. 3.

The hammer is started, stopped and regulated by a foot-treadle extending around the base. By varying the pressure on this treadle, any desired speed or force of blow is instantly obtained. The idler pulley for the driving belt, and the brake band, are reversible so that the hammer can be run in either direction. The anvil is a separate casting and a wood filler is inserted between it and the frame to eliminate vibration. The anvil is secured to the frame by strap bolts and, as shown in Fig. 1, it is offset so as to clear the main frame casting, thus allowing long bars to be held on the dies in any position. The anvil has an independent and adjustable shoe die.

The frame is cast in one piece, is very rigid and occupies little floor space. The ram is of steel and is carefully fitted into heavy V-shaped guides. It is adjustable on the connecting-rod for varying the height above the dies and is at all times almost entirely contained within the guides, thereby insuring accurate alignment of the dies and a true, square blow. The ram guides are cast solid with the frame and to one of them is fitted an adjustable, composition, taper gib for taking up wear. The steel crankshaft is of large diameter, has long bearings and runs in babbitted bushings chambered for oil. The crankpin is adjustable for varying the length of the stroke.

The steel connecting-rod operates on a hard, bronze sleeve and is connected with the spring box. The latter is also of steel and into it are fitted the two spring arms to which the links are hooked. These spring arms are held in place by tension nuts, which, as previously mentioned, serve to maintain and vary the tension on the arms. The spring arms are forged from Swedish steel and are carefully tempered. The links are steel castings.

The brake (which is clearly shown in Fig. 2) will hold the hammer in any position. The treadle working in conjunction with the belt-tightening pulley and band brake, serves to instantly stop or start the hammer. The belt pulley is large and has a wide face, thus giving the driving belt ample contact area. This new hammer is made in seven different sizes. The ram of the smallest size weighs 25 pounds, and the largest size, 200 pounds; whereas the approximate weights of the smallest and largest hammers are 1200 and 4400 pounds, respectively.

WAHLSTROM AUTOMATIC DRILL CHUCK

Where a drilling job requires the use of a number of different sized drills, a lot of time is lost in changing from one size to another. The Wahlstrom automatic drill chuck, made by the Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., and illustrated in Figs. 1 and 2, has been designed to avoid this waste of time. Reference to Fig. 2 will show that this chuck consists of a body *D* surrounded by a shell *E*. This shell is knurled on the outside and when it is desired to change drills, it is merely necessary to grasp the shell and

hold it against the drive of the drill press. This opens the jaws so that one drill can be removed and another inserted in its place. When the change has been made, the shell is released and the new drill is in position ready for use.

The drill is secured in the chuck by means of three rockers *A* which are pivoted in jaws *B;* the latter are carried in the body of the chuck. When the shell is held back in order to open the chuck, it is twisted against the tension of spring *F*, a suitable stop being provided between the body of the chuck and the shell in order to stop the chuck when it has been opened to its maximum capacity. When a drill is inserted and the shell released, the tension of the spring *F* twists the shell around in relation to the chuck body. In so doing, the jaws *B* are forced in toward a common center through their bearing on three eccentric surfaces on the inner side of the shell. This brings the rockers *A* against the shank of the drill and holds it in position ready for use. When the drill is fed up to the work, the rockers *A* swing on their pivots and the eccentric faces of these rockers are forced in against the shank, the gripping being in direct proportion to the force which is required to drive the drill.

Fig. 1. The Wahlstrom Automatic Drill Chuck

In the design of any drill chuck acting upon this principle, it is necessary that the eccentricity shall be very small in order to secure the required grip. This has been the reason for the limited range of previous types of chucks which have been designed along these lines. In the present case, the provision of the jaw extensions *C* have made it possible to greatly increase the capacity. Reference to the two end views shown in Fig. 2 will make it clear that when the jaws are reduced for the smaller sizes of drills, the jaw extensions *C* are located between the jaws and the eccentric surfaces of the shell. This is the case until the jaws have been opened to about one-half of their capacity. In this position the jaw extensions come up against the shoulders in the shell as shown, and the jaws then come into direct contact with the eccentric surfaces of the shell. They are in this position until the chuck has been opened to its full capacity.

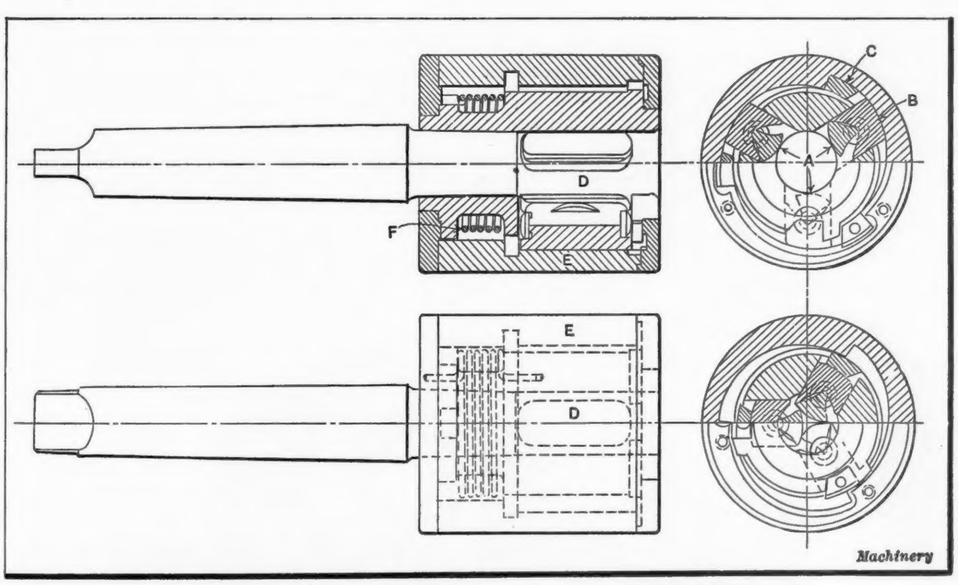


Fig. 2. Cross-sectional View showing Arrangement of Gripping Mechanism

This chuck is suitable for all kinds of drilling, reaming, tapping and counterboring operations where straight shank tools are used. In the case of tapping, it is necessary to grind three flat surfaces on the shank of the tap to provide the necessary drive for backing out the tool. The range of the chuck shown in the illustrations is from a ¾ inch drill down to a No. 33 drill. The chuck will also be placed upon the market in a larger and smaller size. It is constructed entirely of high carbon tool steel with the exception of the jaws *B* and rockers *C;* these are made of high-speed steel. The ¾ inch chuck is commonly made with a No. 3 Morse taper shank, but any other taper can be furnished.

THE WAHLSTROM OIL CUP

Difficulty is sometimes experienced with small oil cups from two causes: first, the cups are difficult to install in cramped positions; and second, the covers in use render it difficult to fill the cups without spilling considerable oil.

The Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., has recently placed a cup upon the market designed to eliminate these difficulties. Instead of applying a hexagon at the base, which requires the use of a wrench to screw the cup into place, the Wahlstrom oil cup has been provided with a slot *A* as shown in Fig. 1. This makes it possible to use an ordinary screw-driver when installing the cup. This is generally a more convenient method and it has a further advantage of not marring the outside of the cup. The type of cover used is pivoted at *D*. This enables the cover to be lifted as shown in Fig. 2, thus providing plenty of room for adding fresh oil or for the admission of a screw-driver when installing. The provision of this pivoted cover also makes it easy to use a wire to clean out the oil channels, should they become clogged.

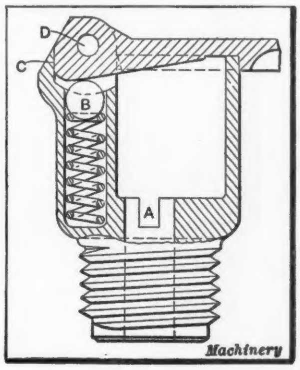


Fig. 1. Cross-sectional View of the Oil Cup

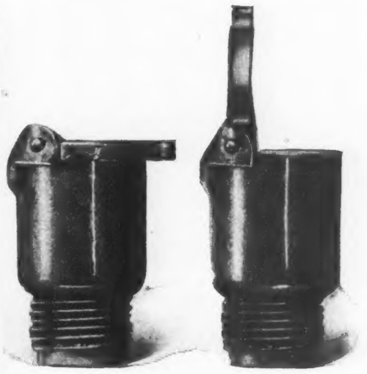


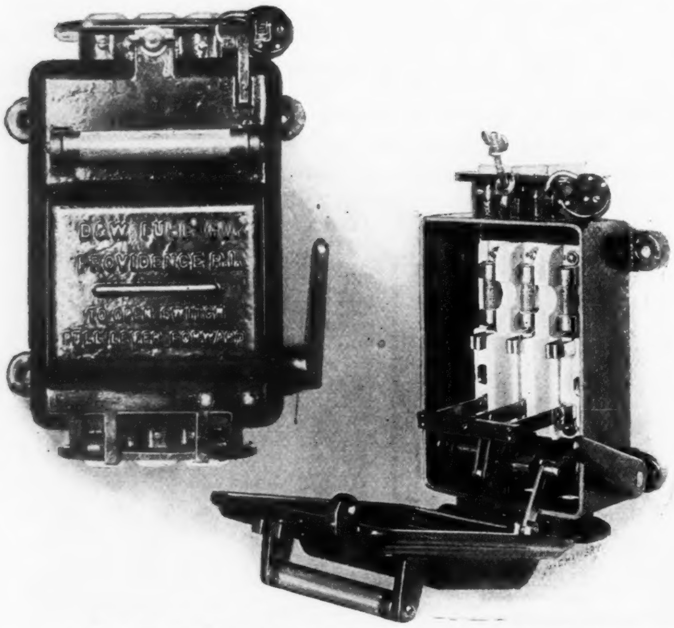
Fig. 2. Oil Cup with Cover Closed and Open

Reference to Fig. 1 will show that there is a spring and ball *B* located in a hole at the left-hand side of the cup. This spring serves the double purpose of holding the cover down when the cup is supposed to be shut, and also of holding it up when the cover is lifted to add fresh oil. In the latter position, the ball *B* is in contact with the surface *C*. The use of this spring does away with the necessity of holding the cover up with one hand while oiling. Where cups are located in close places, this cover design is particularly useful in that it allows the spout of the oil can to be used to lift it. The cup is also made practically dust-proof by the liberally proportioned flange on the cover, which comes down over the top of the cup as shown in the cross-sectional view. These cups are made in seven regular commercial sizes with diameters ranging from ¼ inch to ½ inch.

COMBINED SWITCH AND FUSE BOX

The D. & W. Fuse Co., Providence, R. I., has brought out a new line of fused switch boxes for 250-volt, direct-current circuits. These boxes are particularly adapted for mill service

since they can be locked after the fuses are installed, thereby preventing any tampering with the connections or increasing the capacity of the fuses. They can also be used as a switch, as the circuit can be opened or closed at will, by simply moving the lever located at the side of the box, as shown in the accompanying views. When the cover is opened, as illustrated to the right, the circuit is also opened which makes it impossible to re-fuse the circuit when the switch is closed. The construction of these boxes is simple but substantial, and they will last indefinitely. They are provided with rubber gaskets which make them waterproof, provided the terminal wires are "taped in" at the bushings or protected by outlet hoods when conduit connections are made. To facilitate installing these boxes, removable porcelain bushings are used, through which the cable terminals can be readily passed.



D. & W. Combined Switch and Fuse Box with Safety Lock

THE HALE LOOSE PULLEY

The Cleveland Clutch Co., Cleveland, Ohio, is manufacturing a loose pulley that is quite different from the usual form. The pulley proper has a large hub which fits over a bearing sleeve that is locked to the shaft by a set-screw. When placing the pulley on a shaft, the bearing sleeve is first fastened in position. The pulley is then slipped over the sleeve and the side retaining cover or plate is screwed on. Fig. 1 shows the pulley assembled, and Fig. 2 illustrates the different parts, the retaining cover being to the left and the bearing sleeve to the right.

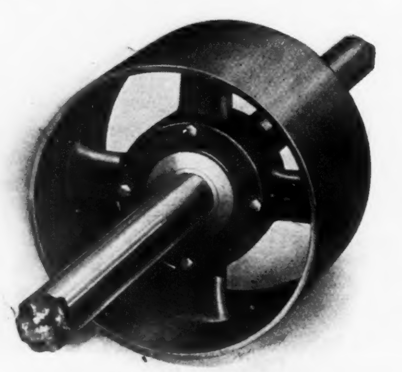


Fig. 1. Hale Loose Pulley

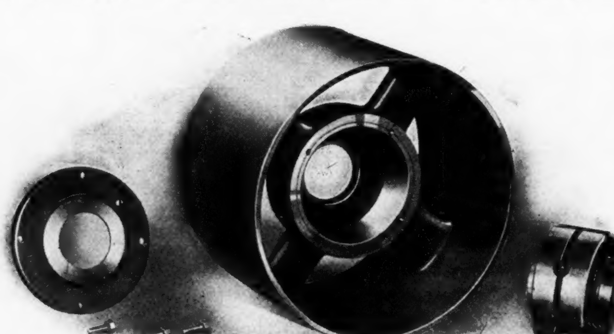


Fig. 2. Parts of the Hale Loose Pulley

One of the noteworthy features of this pulley is the efficient method of oiling the bearing surfaces. The oil is not wasted and the lubricant always remains on the bearing, regardless of whether the pulley is idle or revolving at high speed. The particular pulley illustrated is a 12-inch size and has an 8½-inch face, and the friction surface has the same area as that of an ordinary loose pulley of the same dimensions. The principal features claimed for this pulley are, that it is self-oiling; durable; dust- and dirtproof; oil-tight; economical in the use of lubricant; prevents oil from being thrown on the belt; eliminates wear of the shaft; keeps the lubricant constantly on the bearing; is easily mounted on a damaged shaft; and, when once oiled, requires no attention for months.

ELECTRIC PRECISION GRINDER

The portable, electric, precision grinder shown in Figs. 1 and 2, is the product of the Chicago Pneumatic Tool Co., 1014 Fisher Bldg., Chicago, Ill. This electric grinder is known as the "Duntley No. 6," and is adapted to a large variety of work, being designed for both external and internal grinding. A commendable feature is the adjustable frame, which is milled convex on its lower surface, and rests on a concave shoe, as shown in Fig. 1. When the grinder is applied to a lathe, this concave shoe rests on the tool-post base and is clamped to it by the bolt and nut shown. The center of the grinding wheel arbor is brought in line with the center of the work, by simply pushing the frame back or forth on the concave shoe and then tightening the clamping bolt when the grinder is set in the desired position. This adjustment makes it possible to use this grinder on lathes having a swing of from 16 to 42 inches, inclusive.

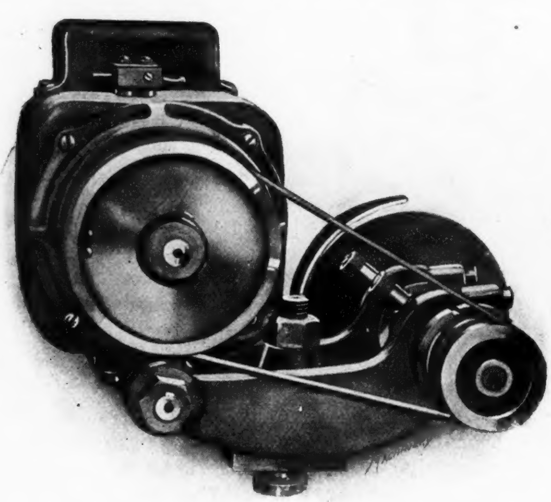


Fig. 1. Chicago Pneumatic Tool Co.'s Electric Grinder

The arbor for external grinding carries a 5-inch wheel (see Fig. 1) and is provided with a split-sleeve bearing, which is tapered on the outside, and can be accurately adjusted for wear. The heads of the cap-screws for fastening the straps which hold the arbor sleeve to the frame, extend only a slight amount beyond the arbor housing itself. This is an important feature, as it permits the emery wheel to be worn down to a small diameter, and allows sufficient clearance between the grinder and the tailstock of the lathe—this is a requirement not found in most grinders of the tool-post type.

The arbor for the internal grinder (see Fig. 2) runs in

Hess-Bright ball bearings, which are located at the ends of the arbor and provide a support close to the wheel and driving pulley. The arbors for external and internal grinding can be

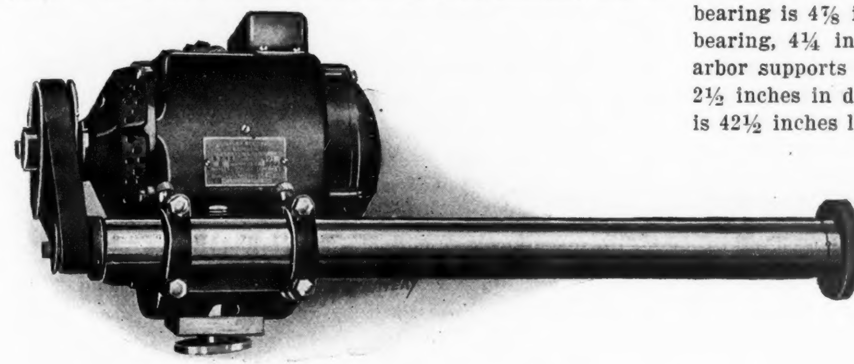


Fig. 2. Grinder illustrated in Fig. 1 arranged for Internal Grinding

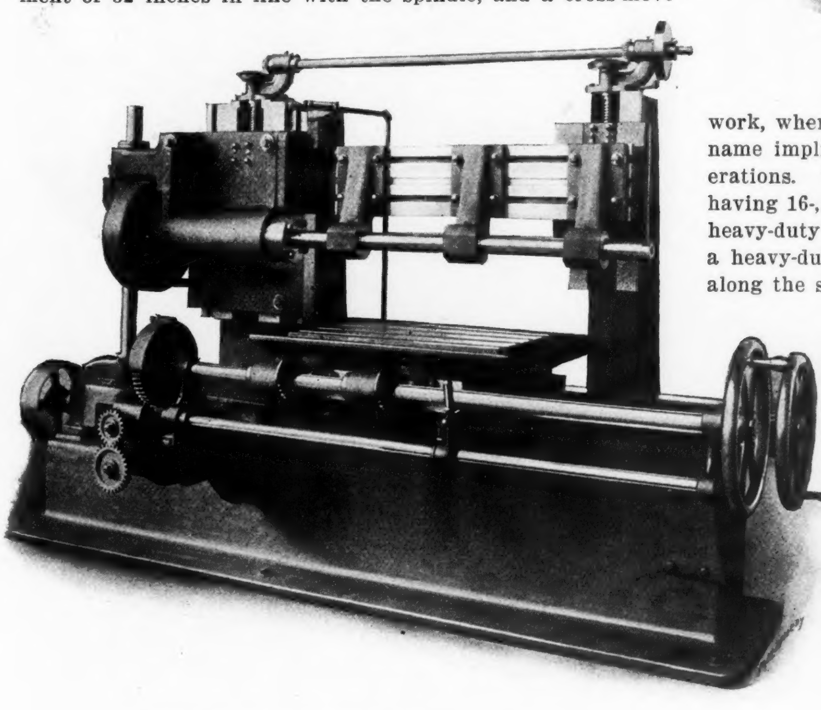
changed in a few minutes by simply removing the cap-screws of the straps which hold the arbor sleeve to the frame.

The motor is mounted on a hinge-pin, permitting it to be swung back to tighten the belt. Pulleys of the desired size to give the proper wheel speeds are furnished, and the motors can be obtained in a variety of types for either direct current or alternating current of the single, two, or three-phase systems.

SPECIAL BEAMAN & SMITH MILLING MACHINE

The milling machine shown herewith has been designed by the Beaman & Smith Co., Providence, R. I., for milling the ends of crankshaft bearings on crankcases. It has a horizontal bed upon which is mounted a work-table that can be traversed laterally on its saddle and longitudinally along the ways of the bed. Two uprights are attached to the bed which support the spindle-saddle and cross-rail. The cross-rail is attached directly to the spindle-saddle and it can be raised or lowered by hand. The horizontal shaft connecting the vertical adjusting screws, carries at the right-hand end a dial graduated to thousandths of an inch to facilitate setting the cutters accurately to depth.

The spindle is driven by a single pulley seen at the left of the machine from which power is transmitted to the spindle through shafting and gearing. The table has a hand movement of 32 inches in line with the spindle, and a cross-move-



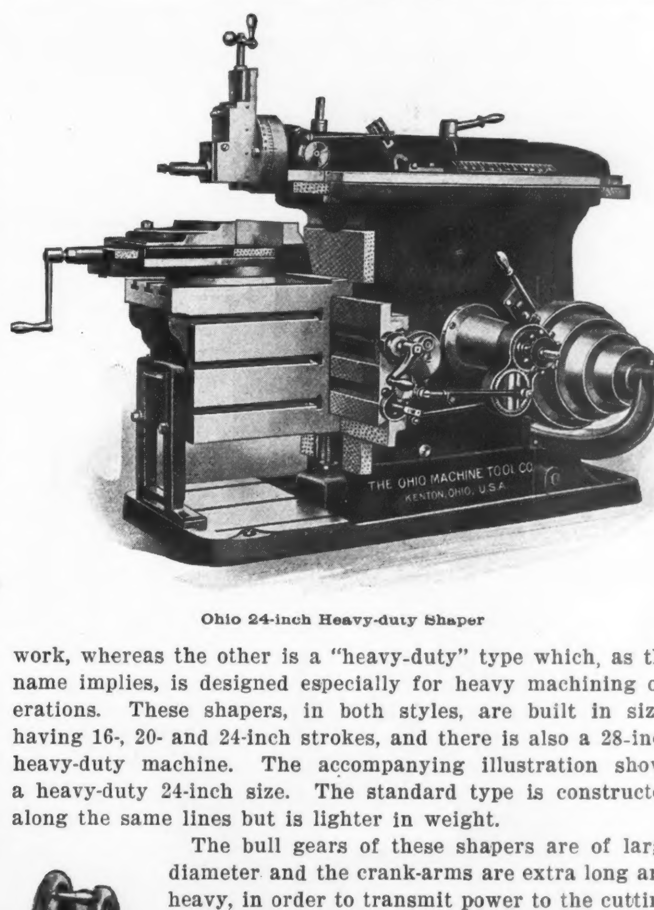
Special Machine for Milling End of Crankshaft Bearings on Crankcases

ment of $11\frac{1}{2}$ inches. There are positive geared feeds for the cross-movement and five changes are available, ranging from $1\frac{1}{2}$ to $6\frac{1}{2}$ inches per minute.

The table has a working surface 18 inches wide and 32 inches long, and it is surrounded by a large oil channel. The spindle is of crucible steel and runs in boxes of hard bronze which can be adjusted to compensate for wear. The front bearing is $4\frac{7}{8}$ inches in diameter, 6 inches long, and the rear bearing, $4\frac{1}{4}$ inches in diameter and $5\frac{1}{2}$ inches long. Three arbor supports are provided having phosphor-bronze bearings $2\frac{1}{2}$ inches in diameter and $5\frac{5}{8}$ inches long. The arbor itself is $42\frac{1}{2}$ inches long and $1\frac{7}{8}$ inch in diameter. The machine is driven by a 4-inch belt, and the ratio of the gearing is 2.7 to 1, giving a spindle speed of 250 revolutions per minute. Lubricant for the cutters is provided by means of a pump. The distance between the uprights is 44 inches, and the minimum and maximum distances from the center of the spindle to the top of the table are, $10\frac{1}{2}$ and $16\frac{3}{4}$ inches, respectively. The weight of the machine is approximately 10,300 pounds.

OHIO STANDARD AND HEAVY-DUTY SHAPERS

The Ohio Machine Tool Co., Kenton, Ohio, has brought out two types of shapers. One is known as the "standard" shaper and is intended for ordinary tool-room and machine shop



Ohio 24-inch Heavy-duty Shaper

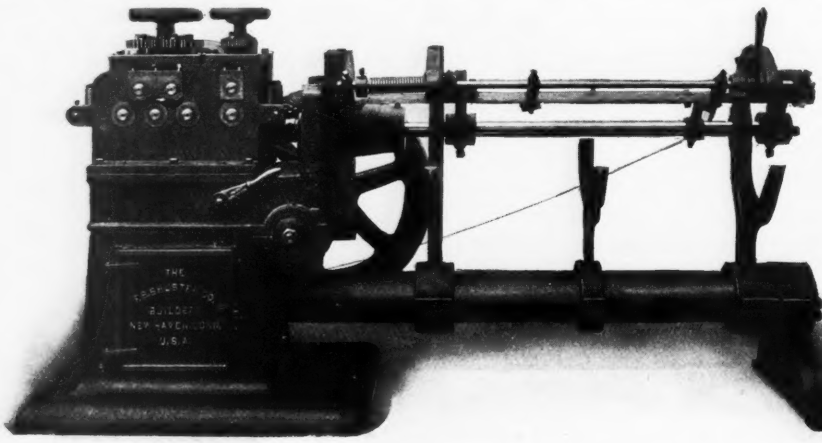
work, whereas the other is a "heavy-duty" type which, as the name implies, is designed especially for heavy machining operations. These shapers, in both styles, are built in sizes having 16-, 20- and 24-inch strokes, and there is also a 28-inch heavy-duty machine. The accompanying illustration shows a heavy-duty 24-inch size. The standard type is constructed along the same lines but is lighter in weight.

The bull gears of these shapers are of large diameter and the crank-arms are extra long and heavy, in order to transmit power to the cutting tool with a minimum of vibration. The 20- and 24-inch sizes have a variable, automatic, vertical power feed for the table. The vertical power feed for the head, which is shown applied to the machine illustrated, is a special attachment. This device feeds the tool either up or down and gives feed variations ranging from 0 to 3/16 inch. It is actuated by a tumbler movement that is positive in its operation. The standard 20-inch machine has a keyseating capacity of three inches, and the heavy-duty type, $3\frac{1}{2}$ inches; whereas the 24-inch sizes in both types have keyseating capacities of $3\frac{5}{8}$ and $4\frac{5}{8}$ inches, respectively. Motor drives are applied to any size shaper and on the 20- and 24-inch machines, the motor is attached to the back of the column. By having these two types, the manufacturers can supply a shaper adapted to the requirements of the shop in which it is installed.

SHUSTER STRIP-METAL STRAIGHTENER AND CUTTER

The accompanying illustration shows an automatic strip-metal straightener and cutter built by the F. B. Shuster Co. of New Haven, Conn. This machine is larger than similar types previously built by this company and embodies several improvements. It is designed for straightening and cutting to accurate lengths (from the coil) such metal as brass, copper, steel, iron, etc. The machine has a capacity for widths up to three inches and will take stock up to 1/8 inch thick. The particular machine illustrated will cut lengths up to four feet but it can be built for any length desired.

There are five straightening rolls and a pair of feed rolls, all of which are enclosed by the housing instead of being outside, which is the construction of the smaller sizes. All the rolls are geared and the upper ones are adjustable to suit the shape and temper of the stock passing through the machine. This adjustment is effected by the handwheels shown on the top of the housing and can be made while the machine is in motion. There are suitable guides at the rear for taking care of various widths and thicknesses of metal.



Shuster Automatic Strip-metal Straightener and Cutter

This machine has a mechanism which stops the feeding of the material while it is being severed. When operating the machine, the metal is placed on a suitable reel at the rear, from which it passes through guides into the straightening and feed rolls. Continuing, it moves past the stationary dies and cutters out into the guide-bar until it strikes a gage previously set for the length to be cut. This throws the feed-releasing mechanism into operation, thus causing the feed to stop and the cutters to come into action. At the same time, the cover of the guide-bar is thrown off and the severed piece drops into the fork-shaped brackets shown. The extension of this machine is similar to that applied to the straighteners and cutters for round, square and hexagon stocks, except that the guide-bar is designed and grooved for strip metal.

LARGE NIAGARA DOUBLE-CRANK PRESS

The large double-crank press shown in Figs. 1 and 2 was recently designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y. This press is adapted for a wide range of work, such as heavy blanking, shearing, forming, embossing, and cold-drawing operations. It is equipped with the Niagara combination friction clutch and brake. The friction clutch is of the multiple-disk type and the friction surfaces are lined with end-grain, hardwood blocks. The clutch is entirely encased and all projecting rotating parts which might endanger the operator when oiling the clutch, are eliminated. The clutch is operated by four sets of toggles and links which are made of steel.

The brake, which works in unison with the clutch, consists of two brake levers which are actuated by a pair of toggles. An interesting feature of the construction is that the pressure on the brake blocks is always equalized, thus avoiding transmitting the pressure of the brake arms to the shaft bearings. The clutch can be started by a foot treadle actuating an automatic device which will stop the press when the slide reaches the highest position. This self-acting device can be quickly thrown out of action and the motion of the press controlled by a hand lever. This lever permits starting and stopping the machine at any part of the stroke.

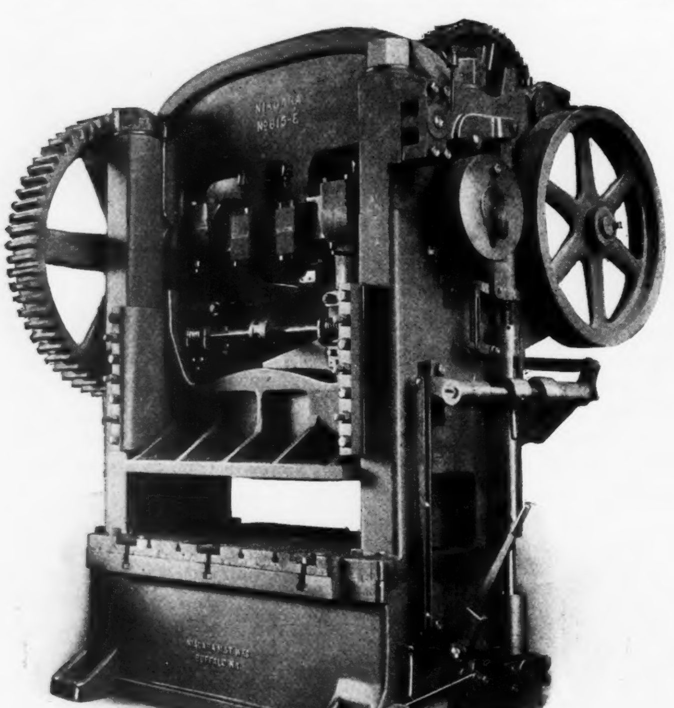


Fig. 1. Niagara Double-crank Press

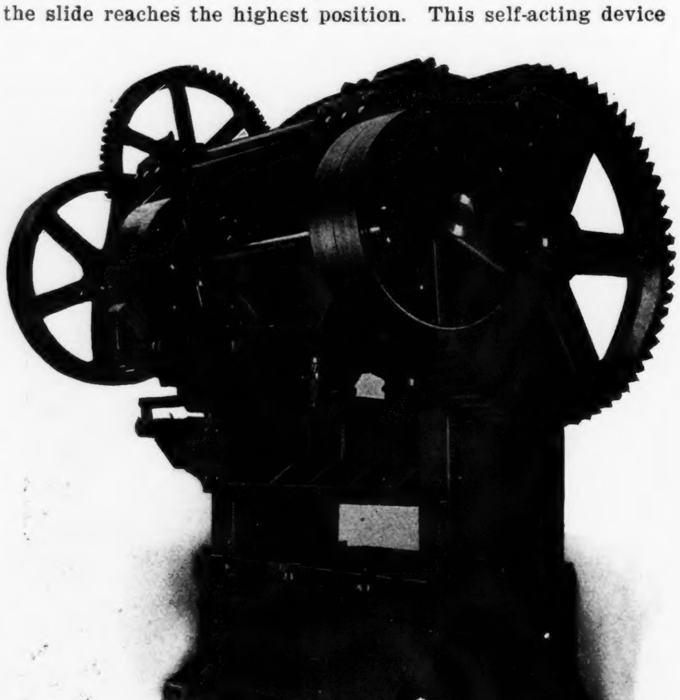


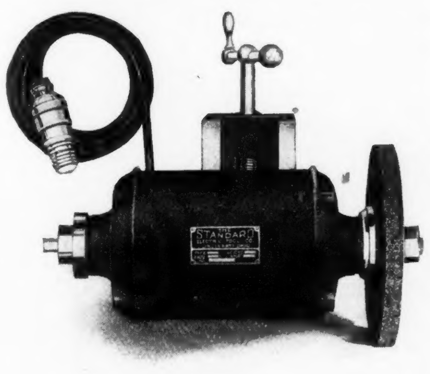
Fig. 2. Rear View of Niagara Press

To guard against breakage, in case the press is accidentally overloaded, there is a safety coupling on the pinion shaft. The housings and arch are held together by four steel tie-rods, $5\frac{1}{2}$ inches in diameter, which are shrunk into place. The slide and gibs have the same means of adjustment common to

all large presses built by this company. The press measures 72 inches between the housings and weighs 60,000 pounds. It covers a minimum amount of floor space, as the drive is located overhead and outboard bearings are eliminated.

PORTABLE ELECTRIC GRINDER

The portable electric grinder shown herewith is made by the Standard Electric Tool Co., Cincinnati, Ohio. This grinder is mounted on an angle-plate and is attached to a lathe by bolting this plate to the toolpost rest. A shank can be furnished instead of the angle-plate attachment, if desired. There is a vertical dovetail slide on the angle-plate which gives an adjustment of four inches for locating the grinding wheel in line with the lathe centers. This grinder can be used for grinding rolls, shafts, bushings, and similar work. It is also adapted for surface grinding on the planer and can be used to advantage on the boring mill for certain classes of work. The bearings are made of phosphor-bronze and are dust-proof and adjustable. The motor is force-ventilated or air-cooled by a special fan mounted on the armature shaft. The armature and poles are built up of the best grade of soft, electrical, sheet-steel laminations, uniformly insulated. This grinder is made in one-half and one horsepower sizes.



Standard Portable Electric Grinder

BAKER BROS. HIGH-SPEED DRILLING MACHINE

Baker Bros., Toledo, Ohio, have added to their line of drilling machines the powerful high-speed, heavy-duty type shown in Fig. 2. A glance at this illustration will give one a better idea of the massiveness and rigidity of the construction than a whole page of description. The machine has a heavy box column and also a box-type, screw-elevating table. It has a single belt drive and the driving train is composed of all hardened steel gears. The shafts are large and are mounted in Hess-Bright ball bearings. A minimum number of gears consistent with the necessary speed changes are in mesh at one time. On the four direct speeds, only three pairs of gears are meshed simultaneously, and there are never more than five pairs engaged at one time.

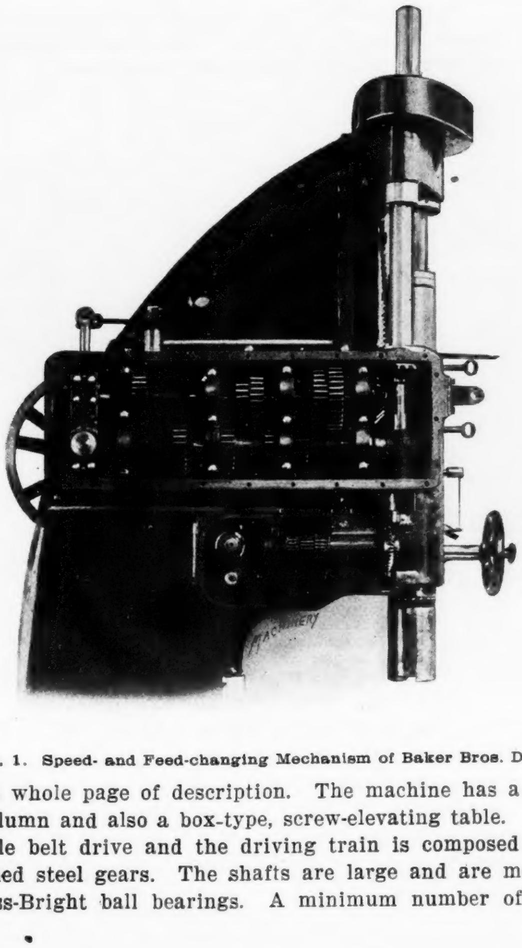


Fig. 1. Speed- and Feed-changing Mechanism of Baker Bros. Drill

There are twelve changes of feed ranging from 0.006 to 0.032 inch per revolution of the spindle. In addition, the feeding mechanism has an attachment which enables any one of the drilling feeds to be increased 3½ times, when the machine is to be used for reaming. All of the control levers are centralized and in convenient positions.

There are eight speed changes controlled by two interlocking levers in such a manner that all of the speed changes can be successively engaged; that is, the machine can be run on each of the eight speeds, beginning at the slowest and increasing to the highest, in eight seconds. A detail view of the machine is shown in Fig. 1 with the gear-case cover removed in order to show the arrangement of the speed- and feed-changing mechanisms. The spindle speeds range from 35 to 351 revolutions per minute and the changes are effected by sliding gears controlled by a lever at the front. There are no dive keys or tumbler gears in the driving train, and the entire mechanism is enclosed in an oil-tight case.

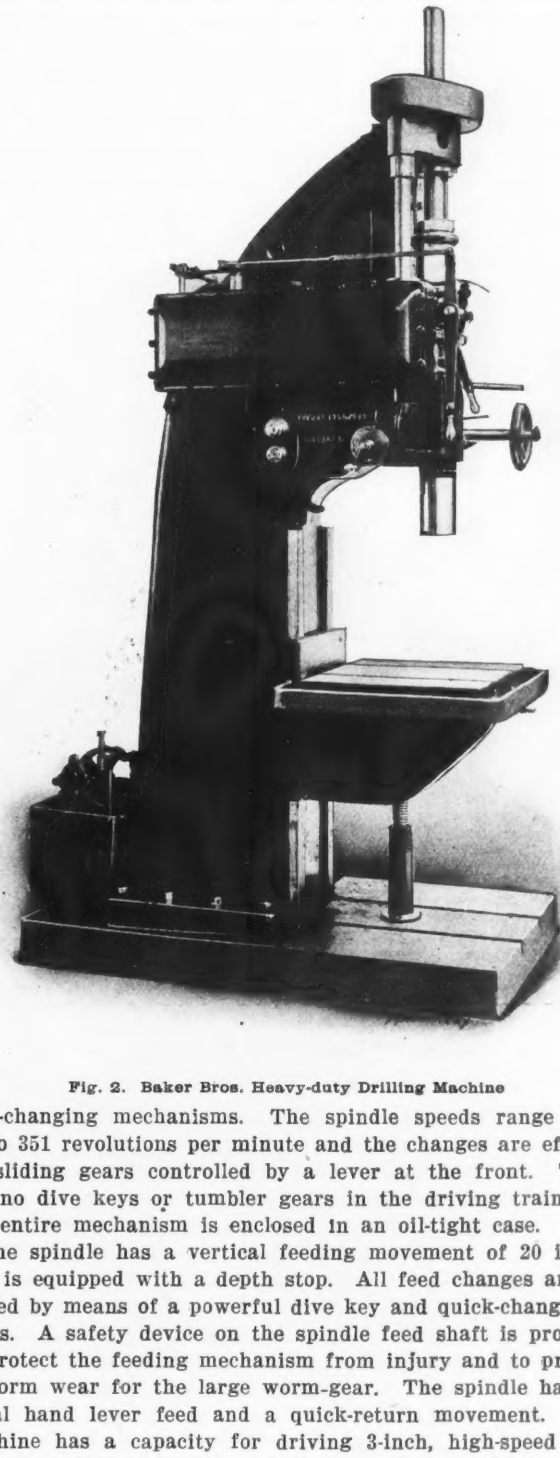


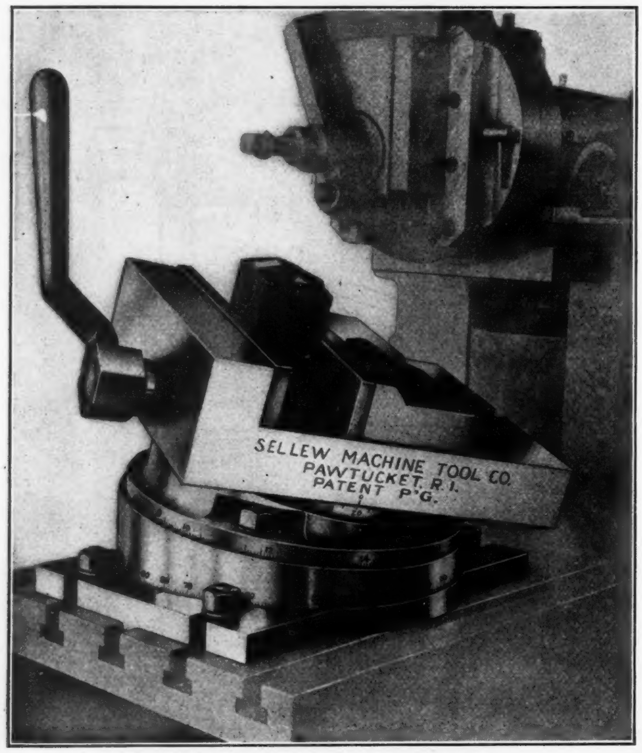
Fig. 2. Baker Bros. Heavy-duty Drilling Machine

The spindle has a vertical feeding movement of 20 inches and is equipped with a depth stop. All feed changes are obtained by means of a powerful dive key and quick-change slip gears. A safety device on the spindle feed shaft is provided to protect the feeding mechanism from injury and to provide uniform wear for the large worm-gear. The spindle has the usual hand lever feed and a quick-return movement. This machine has a capacity for driving 3-inch, high-speed steel drills in solid steel. The spindle is made from high-carbon, hammered, spindle steel forgings and has a minimum diameter of 3 inches and a maximum diameter of 4¾ inches. The thrust is taken on high-duty bearings having ¾-inch balls. The end of the spindle is bored for a No. 5 or No. 6 Morse taper.

The table has a working surface of 20 by 30 inches and a vertical travel of 30 inches. The maximum distance from the end of the spindle to the top of the table is 46 inches. The swing of the machine is 36 inches, that is, 18 inches from the center of the spindle to the column. The drive is by a $3\frac{1}{2}$-inch belt running on an 18-inch pulley. An oil pump, tank and the necessary piping is provided in the equipment. The weight of the complete machine is about 4750 pounds. A compound table of the box knee type can be furnished if desired. The lateral and longitudinal screw adjustments of this type of table enable the work to be positioned quickly and accurately, the handles being so located that the operator can move both simultaneously. Micrometer dials are provided on the screws for accurate adjustment.

UNIVERSAL VISE FOR MACHINE TOOLS

The Sellew Machine Tool Co., of Pawtucket, R. I., is manufacturing a vise for use on shapers, planers, drilling machines, etc. This vise can be set in any plane within the range of its angular adjustment. It is exceptionally low and provides a rigid unyielding support for the work. The vise proper is mounted on two tapering or oblique disks, and by changing the relative positions of these disks, the angular adjustment is obtained. When the thin side of the upper disk is directly above the widest or highest part of the base, the vise is in a horizontal position. By turning the upper disk, any angle



Universal Vise applied to a Shaper

within the maximum represented by the combined angles of both disks, can be obtained. The entire vise can be adjusted about a vertical axis for machining compound angles in connection with tool and die work, and the vise proper can also be turned about an axis perpendicular to the top of the upper disk.

The two oblique disks are graduated on the peripheries so that direct readings can be obtained for the angular adjustments, and radial readings for the adjustment about a vertical axis. Graduations are also provided just under the vise itself to permit adjusting the latter a definite amount regardless of the position of the base. The use of oblique disks for obtaining the angular adjustment makes the vise simple in construction and unusually low. The vise also has a solid metal support direct from the base which makes it rigid, and is conducive to accurate work. It has hardened and ground jaws and is made, at present, in 10- and 12-inch sizes. The 10-inch size has a capacity of $6\frac{1}{2}$ inches, and the 12-inch, a capacity of 9 inches. The weights of the two sizes are 185 and 225 pounds, respectively. One of these vises is shown applied to a shaper in the accompanying illustration.

SHOP AND DRAFTING-ROOM LAMP ATTACHMENTS

A simple form of adjuster for regulating the height of the drop light, is shown in Fig. 1. This fitting can be attached to any flexible cord and it enables the light to be raised or lowered and automatically held at any desired height. This adjuster is made entirely of porcelain and is without springs, latches or winding drums. It operates on the double-pulley tackle principle, there being removable and stationary pulley blocks. The upper stationary member is a disk-shaped block, whereas the lower member is a ball-shaped counterbalancing device. The upper block is held by supporting chains, thereby relieving the rosette and intervening cord of all strain. Any lamp and shade not weighing over two pounds can be balanced by placing the proper number of removable lead weights inside the counterbalancing member.

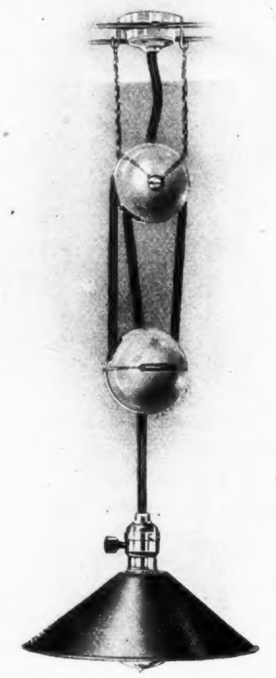


Fig. 1. Adjuster for Drop Lights

This adjuster can be quickly attached to a flexible cord, either before or after the light is in place. The lamp cord from the rosette is clamped in the upper block and continues downward around the sheave of the pulley member, up over the sheave of the upper block and then through a central channel in the counterbalancing ball. Each adjuster is provided with enough removable weights to balance a lamp and shade weighing one pound. The all-porcelain construction insures good insulation and the well proportioned cord channels and sheave surfaces reduce the friction and abrasive action. This adjuster can be applied to any twisted or solid flexible cord.

Another attachment for the electric lamp is shown in Fig. 2. This is simply a clip having a forked end engaging the neck of the socket, and a hook at the other end for catching

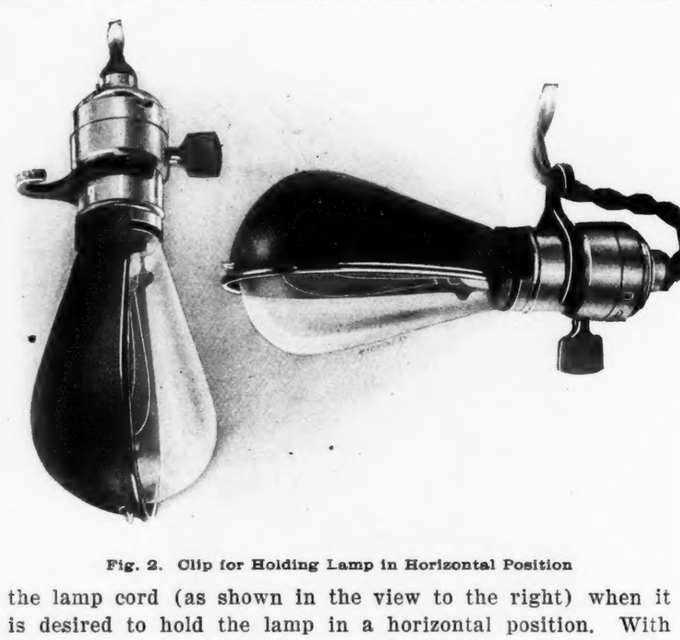
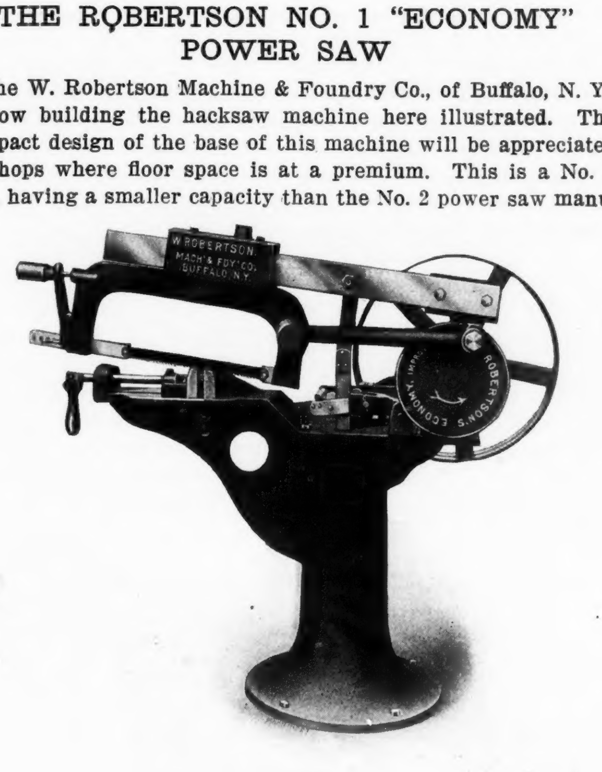


Fig. 2. Clip for Holding Lamp in Horizontal Position

the lamp cord (as shown in the view to the right) when it is desired to hold the lamp in a horizontal position. With this device, a drop-light having a side reflector, can be quickly set to throw the light downward as well as sidewise. The clip is made of a resilient insulating material and it can be applied by snapping the large end over the socket shell. This clip is made to fit any standard socket. Both of these devices are manufactured by the Sachs Laboratories, Inc., 103 Allyn St., Hartford, Conn.

THE ROBERTSON NO. 1 "ECONOMY" POWER SAW

The W. Robertson Machine & Foundry Co., of Buffalo, N. Y., is now building the hacksaw machine here illustrated. The compact design of the base of this machine will be appreciated in shops where floor space is at a premium. This is a No. 1 size, having a smaller capacity than the No. 2 power saw manu-



Robertson No. 1 Power Saw

factured by this company. It cuts on the draw stroke and is equipped with the regular Robertson type of mechanical lift for the idle or return stroke. There is a quick-starting clutch and an automatic stop which comes into action when the cut is completed. The farme is mounted on a finished steel bar and has a bearing of 7 by 2 inches, which is provided with means of adjustment to compensate for wear. The machine has a capacity of 4½ inches in the vise and is driven by a 15-inch pulley of 2½-inch face. It uses either 10-inch or 12-inch saw blades and has a total weight of 180 pounds.

REED-PRENTICE HIGH-SPEED GEARED-HEAD LATHE

The geared-head lathe shown in Fig. 1 is the latest product of the Reed-Prentice Co., Worcester, Mass. This lathe embodies several new and important features and is designed to give a high production with a minimum of power consumption. Formerly there was considerable friction in the bearing which supported the driving pulley, due to the high tension of the driving belt necessary because of the heavy cuts incident to the use of high-speed steels.

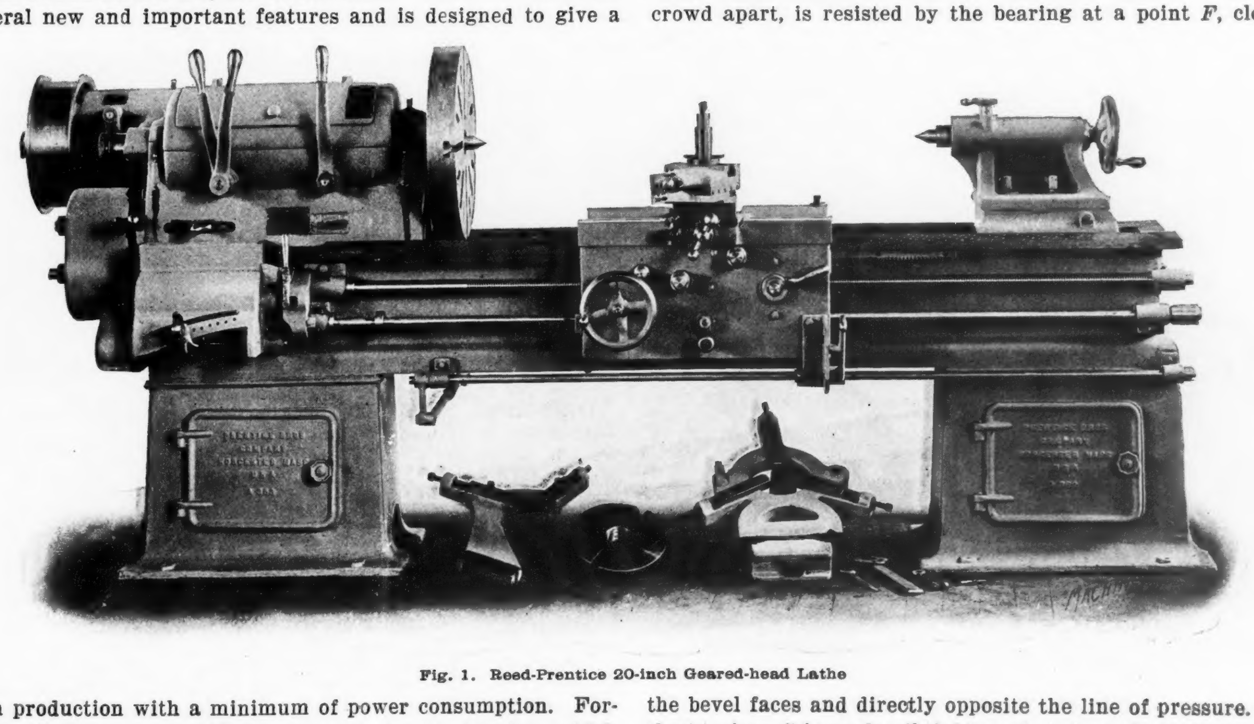


Fig. 1. Reed-Prentice 20-inch Geared-head Lathe

In the design of this new lathe, the hood *A* for the reversing mechanism (which is used principally for screw cutting purposes) and the support *B* for the pulley, are cast integral with the main head casting, as shown in Fig. 2. This gives a very rigid construction. The flanged pulley is mounted at the left end of the head, and ball bearings *C* of the "double purpose" type are used so that both radial and end-thrust loads will be provided for. The bearings are so designed that wear can be compensated for, although there is not likely to be trouble from this source. The bearings and balls are of the best alloy steel and are accurately made.

The pulley has offset or curved spokes in order to locate the rim and center of the belt, directly over the center of the supporting ball bearings. To prevent the driving belt from becoming oil-soaked and losing a large part of its pulling power, there is an annular ridge *D* on the hub of the pulley and in the center of the bearing recess, so that whether the

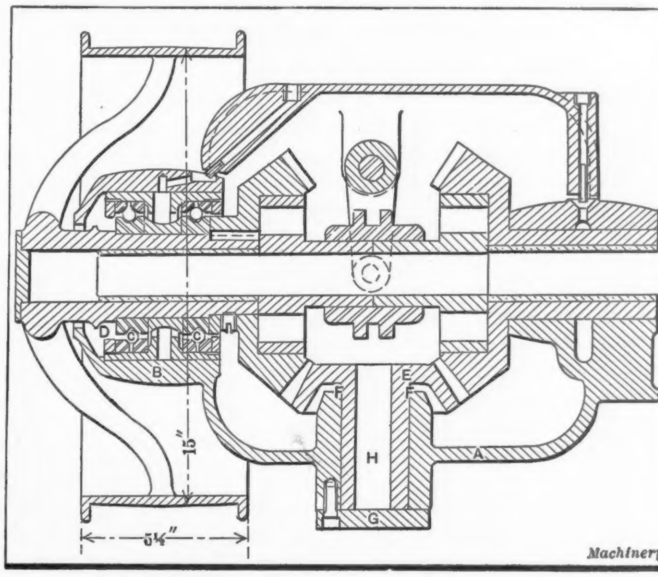


Fig. 2. Reversing Mechanism of Reed-Prentice Lathe

pulley is at rest or in motion, the oil dropping into this recess will not work its way along the spokes to the face of the pulley and then onto the belt.

The method of mounting the intermediate bevel gear provides a very substantial support. When subjected to a working load, whatever tendency there may be for the bevel gears to crowd apart, is resisted by the bearing at a point *F*, close to the bevel faces and directly opposite the line of pressure. The thrust piece *G* is made oil-tight so that the hole *H* through the bevel gear can be filled with oil. This oil flows through a series of holes drilled through the hub of the gear and lubricates the bearing surface. The oil also forms a cushion be-

tween the walls and is said to eliminate, to a great extent, the metallic vibration between the revolving parts.

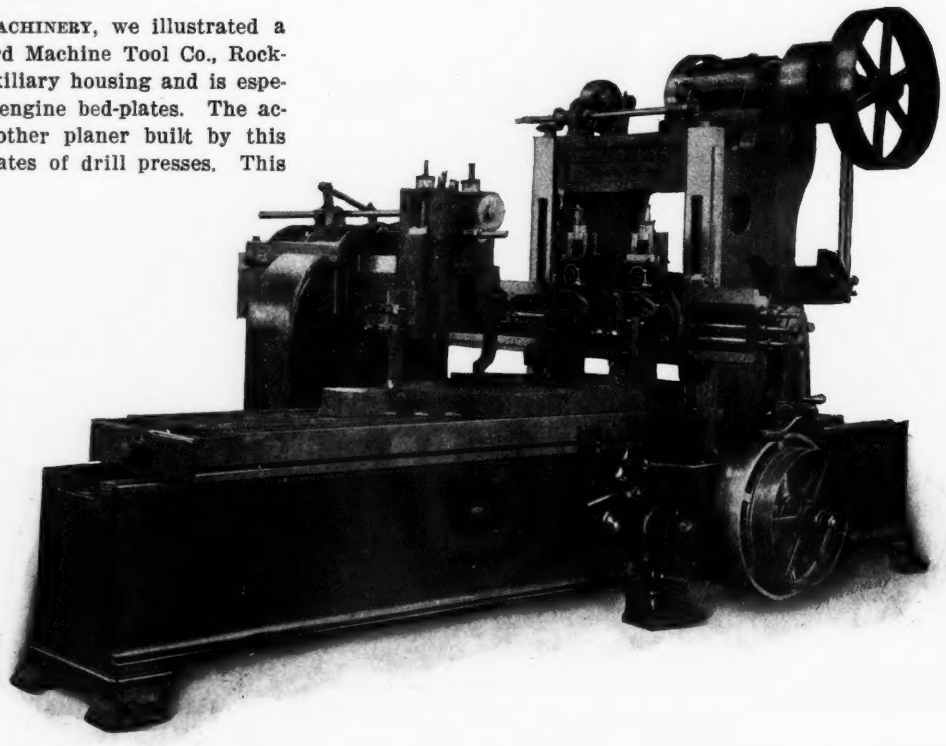
With this form of drive, any size or type of motor can readily be applied. The motor is fastened to a vertically adjusted bracket on the rear side of the leg and by means of the mechanical adjustment, the tension of the belt can be adjusted to any degree required. When equipped with a motor drive, the lathe is a complete unit having its power plant, reversing mechanism for thread cutting, and a complete range of thread and feed changes. The headstock is heavier than that of former designs and has several improvements. There is a larger hole through the spindle, larger centers and a heavier spindle nose, etc. There is also a better arrangement for overcoming the centrifugal force of the friction fingers, which has a tendency to open the friction at high speed and cause it to drag in its cup.

ROCKFORD FOUR-HEAD PLANER WITH SPECIAL HOUSING

In the September number of MACHINERY, we illustrated a special planer built by the Rockford Machine Tool Co., Rockford, Ill. This machine has an auxiliary housing and is especially designed for machining gas engine bed-plates. The accompanying illustration shows another planer built by this company for machining the baseplates of drill presses. This planer also has a special housing, although the construction differs considerably from the machine formerly described.

By referring to the illustration, it will be seen that there is a special housing carrying two tool-holders which are mounted on a ram of square construction. This ram is supported by the housing and has a lateral feeding movement, whereas the tool-slides are adjustable vertically. The power feed for the ram is obtained from a friction at the rear of the machine, which is mounted on the intermediate shaft of the planer. This friction transmits the motion to the horizontal shaft seen at the top of the housing, which connects through gearing with the horizontal feed-screw of the ram. The feeds are controlled and reversed by a trigger gear located in front of the head within easy reach of the operator. The machine is equipped with this company's standard four-speed drive giving four cutting speeds with a constant return. It is arranged for a belt drive direct from the lineshaft, eliminating the usual countershaft.

When a drill press base is being planed, the different surfaces are machined as follows: The flat T-slotted base is planed by the two heads on the regular cross-rail. While this is being done, the rear head of the special attachment planes the top surface of the hub for supporting the drill press column, while the front head planes the pad for the outer bracket at the rear end of the base. By the use of this special attachment, three separate surfaces which vary in height are planed simultaneously. This machine is said to handle this work very satisfactorily and the castings are planed in one-half the time previously required on a similar machine without the special attachment. Of course, when an ordinary planer is used, it is necessary to plane the work at three different settings, inasmuch as the surfaces are on different planes.



Special Planer for Machining Upright Drill-press Bases

GURNEY ANNULAR BALL BEARING

The Gurney Ball Bearing Co., Jamestown, N. Y., has recently placed upon the market the form of annular ball bearing herewith illustrated. The balls of this bearing are carried in a solid cast separator, which is shown beside the assembled bearing. In mounting these bearings, the inner races should have a light driving fit on the shaft, while the outer races are made a free fit in the housing. No filling slots are used and the method by which the balls are held between the races is such that the bearing is capable of carrying light thrust loads. The inner races are stamped with a number and the outer races with the corresponding number, and also the name "Gurney." The bearings are assembled in such a way that the markings on the inner and outer races are on opposite sides, and when a thrust load is to be carried the arrangement should be such that the thrust on either race comes against the stamped sides.

Gurney Ball Bearing and Alloy Retainer

NEW MACHINERY AND TOOLS NOTES

Ink Wash: W. G. Bond, P. O. Box 229, Wilmington, Del. This wash is applied by dampening the surface to be erased with a moist cloth. The ink is softened in one or two minutes and can then be wiped off. The wash is put up in one-ounce and four-ounce bottles.

Rotary Chucks: Pratt & Whitney Co., Hartford, Conn. Double and quadruple rotary chucks for the vertical spindle surface grinder built by this company. The double chuck enables two pieces to be ground simultaneously and the quadruple chuck, four pieces. The double chuck is adapted to concave grinding.

Stand for Portable Drills: Chicago Pneumatic Tool Co., Chicago, Ill. Drilling stand built to hold the Duntley portable electric drilling machines. The drill can be attached or detached very quickly and the stand will take either of the standard portable machines having capacities for drilling 3/16 or 1/4-inch holes in steel.

Radial Drilling Machine: Fosdick Machine Tool Co., Cincinnati, Ohio. New design of radial drilling machines built

in sizes having $2\frac{1}{2}$- and 3-foot arms. These machines have a geared feed of the drive-key type, instead of the belt feed formerly used. The reverse and rapid traverse frictions have been made more powerful and the round table has been replaced by a box table.

Bench Filing Machine: Edge & Edwards, 34 N. 11th St., Newark, N. J. Bench filing machine, the table of which can be adjusted to any desired angle by means of two thumb-screws. The reciprocating file-holder slides in two bearings placed five inches apart. The upper bearing is bronze-bushed and can be adjusted for wear. The file-holder carries with it a cap which entirely covers the upper bearing.

Cutting-off Machine: The W. P. Davis Machine Co., Rochester, N. Y. Six-inch cutting-off machine having a geared scroll chuck on the rear end of the spindle, which is operated by a handwheel instead of a pin, as formerly. This handwheel enables the operator to make adjustments quickly. A splash guard has also been placed over the front chuck to prevent the cutting compound from flying about.

Aloxite Cloth Rolls: The Carborundum Co., Niagara Falls, N. Y. Aloxite rolls of abrasive cloth having widths varying from one-half to two and one-half inches. The cloth is tightly rolled on metal spools, each containing fifty yards. These rolls can be kept on a rack or in any convenient place in the shop. They prevent waste of material and loss of time. The Aloxite cloth is clean and sharp and cuts fast. It is made with various grades of grit.

Telpherage System: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Telphers for handling miscellaneous packages in freight terminals, transfer stations, etc. The telpher train runs on an elevated, single-rail track and consists of a motor-driven tractor with one, two or three trailers. Each trailer is equipped with a motor-operated hoist. The tractor motor and trailer-hoist motors are controlled by an operator stationed in the cab of the tractor.

Convertible Open-side Planer: Detrick & Harvey Machine Co., Baltimore, Md. This planer is primarily a double-housing type, but by removing the outer housing or post, the machine can be converted into an open-side planer, thus greatly increasing its range and adaptability. The note published in the September number relating to this machine, was incorrect in that it referred to the planer as an openside type which could be converted into a double-housing machine.

Belt Shifter: The W. P. Davis Machine Co., Rochester, N. Y. Belt shifter applied to this company's lathe counter-shafts for shifting the belt from one step of the pulley to another. The device is located on the shifting rod and it leads the belt from one step to another without injuring it. In shops where the ceilings are high, it is difficult, with the usual arrangement, to change the speed of a belt-driven lathe without the use of a pole. This belt shifter is now a part of the company's standard equipment.

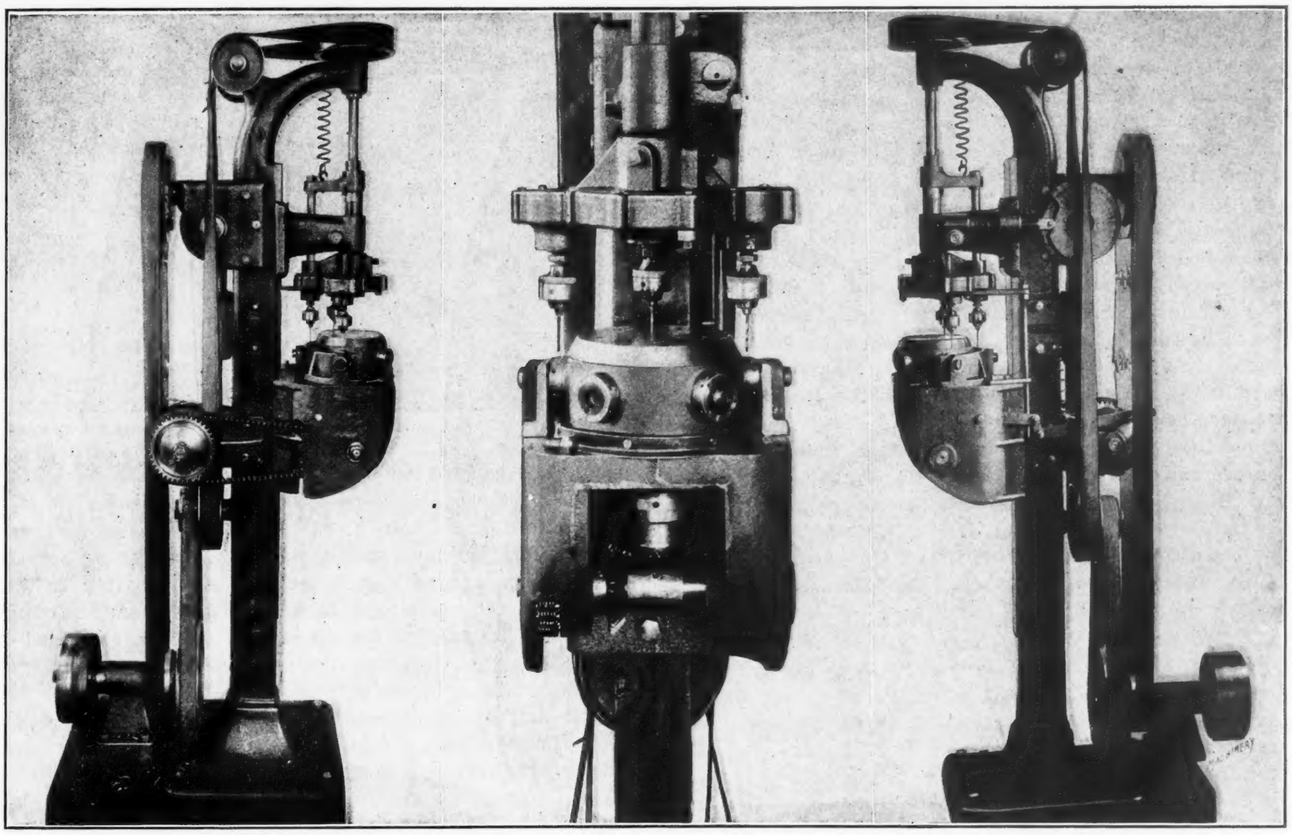
Portable Slotting Machine: Newton Machine Tool Works Inc., Philadelphia, Pa. Portable slotting machine driven by a ten horsepower Westinghouse reversing motor. The saddle has a power cross-feed of 48 inches, and if a greater traverse is required, the upright or vertical column can be adjusted by hand on the base. The length of the stroke is controlled by a master switch operated by adjustable trips or by hand. This tool has a cutting speed on the downward stroke ranging from 20 to $37\frac{1}{2}$ feet per minute and a quick return varying from $42\frac{1}{2}$ to 75 feet per minute. The complete weight of the machine is 23,000 pounds.

Thread-rolling Machine: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. Automatic machine for rolling threads on round shells having flanges or steps. It is also possible to handle straight, cylindrical pieces. The shells to be threaded are placed in a chute and are released by an automatic trip. The chute is made in two sections and the lower half swivels and carries the shells in line with the lower chuck. An automatic pusher forces the shell into the chuck where it is held by a retainer, while the upper chuck moves in and rolls the thread. At the completion of the thread-rolling operation the finished shell is automatically ejected. This machine has a capacity of 30,000 shells in ten hours, and will roll diameters varying from $\frac{1}{2}$ to 3 inches.

* * *

FRANKLIN AUTOMATIC CAP-SCREW DRILLING MACHINE

An automatic cap-screw drilling machine, which reduces the work of four men to one, is the latest product of the tool-construction department of the H. H. Franklin Manufacturing Co., 203 So. Geddes St., Syracuse, N. Y. This automatic cap-screw drilling machine, three views of which are shown herewith, has the capacity of drilling holes in two thousand cap-screws a day. It is a continuously operating drill which drills three cap-screws at a time. Formerly the cap-screw holes were drilled on four separate machines. Each machine drilled one hole at a time, and two minutes was required to drill the holes in one cap-screw. This new machine not only drills three cap-screws at a time but, after the cap-screw is completely drilled, it is automatically forced from the machine and all the operator has to do is to insert another cap-screw. This one machine will take care of the drilling of all the cap-screws needed in the manufacture of Franklin automobiles.



Automatic Machine that will drill Holes in 2000 Cap-screws a Day—built by the H. H. Franklin Mfg. Co.

The turret in which the cap-screws are inserted, holds five at a time. There are three drills operating simultaneously and each one drills a hole through one cap-screw. After the holes have been drilled and the drills back out, the turret revolves and, at the same time, each cap-screw is turned over

so that when it arrives at the next drill, a hole is drilled through another side. In this way each cap-screw has a hole drilled through it by each one of the three drills. After the third drill has finished its work and the turret revolves again, the screw is ejected from the machine automatically.

The turret revolves through an arc of 72 degrees for each indexing and the screws are revolved through an arc of 120 degrees. The turret is worked about by a cam. As the turret revolves, an automatic spring-plunger ejects the cap-screw which has been completely drilled. The drilling head is also fed by a cam which is shown in the view to the right. This cam engages a horizontal spring-plunger having a rack cut on the front end which meshes with a pinion connecting with the spindle quill. At the back of the turret there is a guide which holds the three cap-screws being drilled, firmly in their places. The machine uses 3/32-inch drills and will drill cap-screws from 5/16 inch to 1/2 inch in diameter.

These cap-screws are used in all parts of the Franklin motor and car. The object in drilling holes through the heads of the cap-screws is for locking them. When the engine has been assembled, a wire is drawn through the holes in the cap-screws, completely locking them and preventing their working out, thus providing a perfect safety device.

* * *

F. A. GEIER TWENTY-FIVE YEARS WITH CINCINNATI MILLING MACHINE CO.

Frederick A. Geier, president of the Cincinnati Milling Machine Co., gave a dinner on Friday evening, September 13, in Cincinnati to some of his friends and business associates to celebrate the twenty-fifth anniversary of his connection with the business. The growth of the Cincinnati Milling Machine Co., which operates one of the two or three largest and best equipped machine tool works in the world, has been coincident with the advance of the machine tool industry in this country, and illustrates in a striking manner what can be accomplished by energy, perseverance and business ability. For the steady and continued development of this great enterprise from small beginnings, Mr. Geier is responsible, although he has had the help of able mechanics from the outset; and it is fitting that his twenty-fifth anniversary should be celebrated in company with several of the men who helped him to achieve success, as well as others well known in the machine tool industry and in Cincinnati business circles. Those present at the dinner were: H. T. Atkins, Albert Bettinger, George H. Bohrer, E. M. Chace, George D. Crabbs, A. L. DeLeeuw, E. F. DuBrul, Lewis N. Gatch, Frederick V. Geier, Dr. Otto P. Geier, P. O. Geier, C. S. Gingrich, Louis J. Hauck, Prof. F. C. Hicks, J. C. Hobart, Robert Hochstetter, Fred Holz, Sr., F. W. Jaeger (New York), George H. Kattenhorn, Ernst Krause (Vienna), Louis S. Levi, William Lodge, P. G. March, Alfred Marshall, George E. Merryweather, James P. Orr, George Puchta, B. B. Quillen, H. M. Ramp, Sherman Schauer, Prof. Herman Schneider, Murray Shipley, Nelson W. Strobridge, Dr. C. W. Tangeman, A. H. Tuechter, C. Wood Walter, Dr. J. M. Withrow.

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JOINT MEETING OF A. S. M. E. AND V. D. I.

The council of the American Society of Mechanical Engineers has accepted an invitation from the council of the Verein Deutscher Ingenieure to hold a joint meeting with them in Leipzig, June 23-25, 1913. The meeting will be followed by an official tour of the industrial centers of Germany and will include a trip on the Rhine and special opportunities for a comprehensive study of the Great Museum of the Technical Arts and Industries at Munich. Many establishments will be thrown open that could not be visited under other auspices, and extraordinary and unique opportunities will be afforded the members of the party to familiarize themselves with the latest developments in every industry. Invitations to visit firms throughout Germany have been received.

It is desired that the party be large enough to warrant chartering an entire steamer. This would afford a minimum expense with a maximum of pleasure and personal comfort. Past President E. D. Meier is chairman of the committee on arrangements.

DIE CASTING AUTOMOBILE MOTOR BEARINGS

The manufacture of die castings is one of the numerous lines of manufacture which has advanced rapidly with the growth of the automobile industry. The production of die castings originated with the H. H. Franklin Mfg. Co., Syracuse, N. Y., about nineteen years ago. As is generally known, die castings are produced in steel dies instead of sand molds. By the substitution of steel dies for the sand molds and the use of pressure for conveying the metal from the pot into the die, a degree of smoothness and accuracy is secured which equals, and often surpasses, that obtained by the usual machining operations. The result is that the castings are practically ready for assembling without additional machine work.

At first the die-casting process was confined to the manufacture of electrical instruments, phonographs, computing machines, etc., for producing small, accurate parts which were expensive to finish by the common methods of machining. When the Franklin Co. entered the automobile field, experiments were made with die casting in order to determine to what extent it could be used in automobile construc-

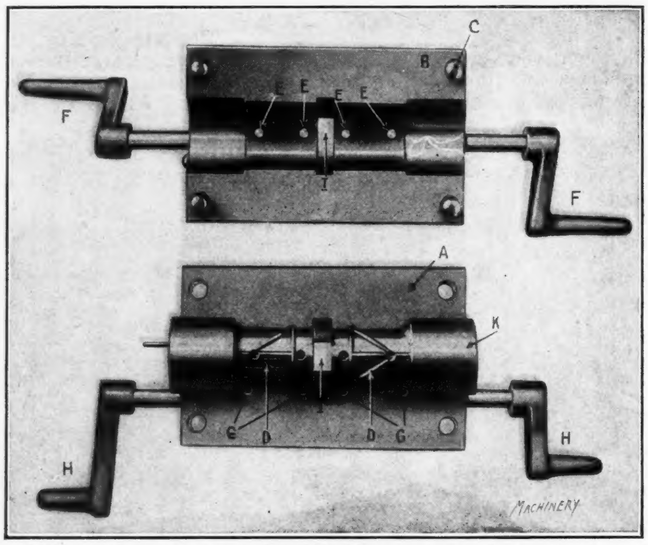

Fig. 1. Die used by H. H. Franklin Mfg. Co. for Producing Bearings by the Die-casting Process

tion. For most automobile parts, either because of their size or intended use, the process was not practicable, but for the production of bearings it was found ideal. The accuracy of the die-cast bearings makes additional machining operations unnecessary and only such scraping and reaming as is customary in the assembling of machined bearings, is required. The high pressure of the die-casting process, combined with the chilling received from the die, gives a hard, close-grained bearing surface, which is of considerable value.

The first die-cast bearings used in automobile construction were for the connecting-rods of the Franklin 1904 motors. These bearings were made of hard babbitt and replaced machined phosphor-bronze. Their success was so marked that babbitt has almost entirely replaced phosphor-bronze as a bearing material in the Franklin motor. It is probably true that one grade of babbitt will not meet all conditions, yet the range of babbitt metals would seem to be sufficiently wide to insure satisfactory results. For instance, in an engine where the heat generated is purely frictional, the addition of a small percentage of lead is probably an advantage, although in engines where the bearings are subject to external heat, a tin, antimony and copper babbitt, devoid of lead, is imperative.

The construction of one of the Franklin dies is illustrated in Fig. 1. The die consists of upper and lower plates which are held rigid by dowels *C*. On the lower half is located the main core *K* and in this are the cores *D* for the oil grooves. These oil-groove cores are either formed by cutting down the main core so as to leave the oil-groove cores raised in relief, or by slotting the main core and "letting in" small cores, which are then located securely. The lower half also contains a set of ejector pins *G* operated by levers *H*. The upper half is more simple. The depression conforms to the outside

of the bearing, and contains the cores E for the dowel holes. These cores are operated by levers F, and also act as ejectors in case the bearings stick in the upper half of the die.

Both halves contain corresponding gate holes I in which the gate operates. When in operation, the closed die is fastened between the upper and lower halves of the die vise, which is placed directly over the casting machine. The cores for the dowel-pin holes are thrust forward and the ejector pins are drawn back even with the face of the die plate, after which the gate is turned back to allow the metal to enter. The metal is then forced in, and when the die is full the gate is sheared off and only a slight mark (which is sometimes imperceptible) is left instead of the usual heavy sprue common in sand castings. The die remains closed only long enough for the casting to set. When it is opened and the ejector pins are thrust forward by means of levers H, the casting is loosened from the main core where it usually sticks

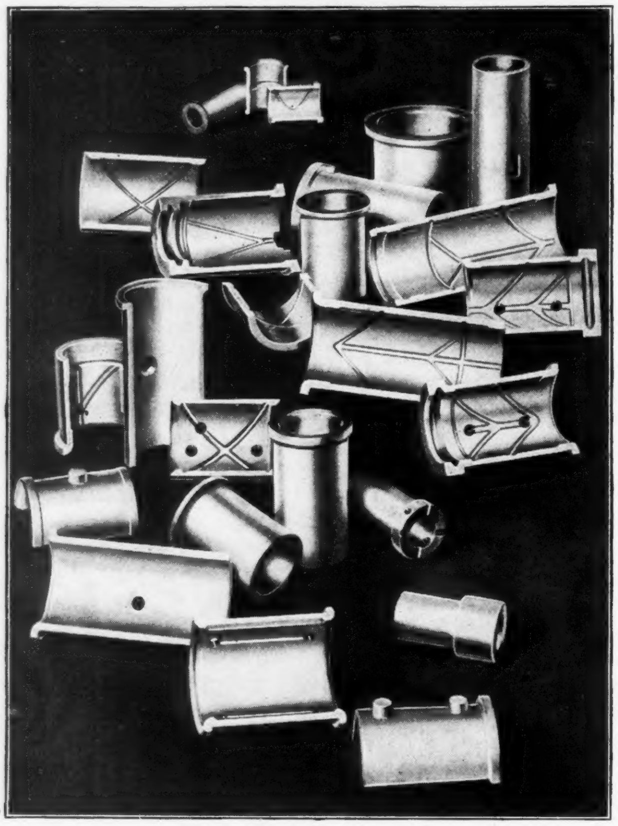

Fig. 2. Group of Die-cast Bearings

somewhat. Fig. 2 shows a number of bearings produced by the die casting process.

The construction and working of the various dies differ, of course, in accordance with the parts to be produced. On account of the effect of high temperature on the dies, the metals available are limited. At present, lead, and tin and zinc base alloys are chiefly employed.

The accessory manufacturers have found die castings, especially of the harder alloys, well adapted to such parts as timer bodies, and the framework of magneto and lighting systems. In addition to the bearings, the automobile manufacturers are using die castings extensively for such parts as oil and water pumps. As the process is constantly being developed, both in regard to materials used and the size of the castings made, it is probable that die castings will in the future have an even greater place in automobile construction than at present.

* * *

MACHINERY's tenth annual outing will be held on October 19, following the National Machine Tool Builders Association convention. It will be of a similar character to the previous outings, comprising a steamer trip in the waters around New York.

* * *

In selecting the number of teeth in a gear, care should be taken to select such numbers as can be obtained by ordinary indexing methods, without the use of special gears.

PERSONALS

Lucius I. Wightman, a well-known publicity man, recently joined with Joseph A. Richards & Staff, Tribune Bldg., New York, forming the firm of Wightman & Richards.

George W. Burley, instructor of machine shop practice in Sheffield University, England, and a well-known contributor to the British and American mechanical journals, sailed for home September 5, having spent a month in the United States.

F. G. Kretschmer of F. G. Kretschmer & Co., Frankfort-on-Main, representative in Germany of many well-known American machine tool builders, will visit the United States early in October. His address during his stay will be Hotel Astor, New York.

Louis L. Burghoff, lately connected with the New England Watch Co., Waterbury, Conn., as assistant superintendent, has taken a position with the Remington Arms–Union Metallic Cartridge Co., as assistant equipment engineer of the gun works at Ilion, N. Y.

Dr. Conrad Matschoss, lecturer at the Royal Technical Institute (dozent der Konigliche Technische Hochschule) Charlottenburg, Berlin, Germany, and a writer on industrial science, is making a tour of American manufacturing centers as representative of the Verein Deutscher Ingenieure (Society of German Engineers). Dr. Matschoss is keenly interested in the comparative average intelligence and educational qualifications of German and American workmen.

Prof. George B. Thomas of Colorado College, Colorado Springs, Colo., was selected by the Westinghouse Electric & Mfg. Co., to take charge of twenty-eight representatives of the engineering faculties of twenty-four colleges in the United States who were on the payroll of the company at the works during the past summer. These instructors were studying the practical side of engineering so as to be better fitted to instruct their students. They were engaged as regular employes and were assigned check numbers the same as other workmen. The work made them familiar with the requirements of engineering work and the advances that are being made in the design of electrical apparatus.

* * *

OBITUARIES

Milton G. Puffer, inventor of the machine for making envelopes, died recently at Willimantic, Conn., aged ninety-three years.

John Hope, inventor of the pantograph engraving machine and other devices used in engraving, died at his home in Providence, R. I., September 8, aged ninety-two years.

William S. Lamson, inventor of the Lamson carrier system for store service, and treasurer of the Lamson Consolidated Store Service Co., died at his home in Lowell, Mass., August 16, aged sixty-six years.

Charles F. Putnam, president of the Putnam Machine Co., Fitchburg, Mass., and one of Fitchburg's best known business men, died August 29 at Massapequa, L. I., aged sixty-seven years. Mr. Putnam had been in poor health for a year and a half but attended to his daily duties with the Putnam Machine Co., up to the time of going to Brooklyn, N. Y., in May, where his daughter lived. His entire business life was devoted to the Putnam Machine Co., with which he was connected in various capacities during his earlier life. Shortly after the death of his father, Salmon W. Putnam, in 1872, the company was reorganized, at which time the deceased was elected president, his brother Salmon W. Putnam, Jr., vice-president, and the late Henry O. Putnam, treasurer. Mr. Putnam was married in 1872 to Miss Coralie J. Lawrence of Pepperell. A daughter, Mrs. Edith Ormsbee of Brooklyn, a brother and four sisters survive him.

WILLIAM J. FLATHER

William J. Flather, one of the founders of the Flather machine tool companies of Nashua, N. H., died at his home in Nashua, September 10, 1912, of heart failure, following a short illness caused by arterial sclerosis.

Mr. Flather was born in Norwich, England, in 1841. The family moved to Bradford in 1849, where, after receiving a common school education, he entered the employ of his uncles, William and Henry Hodgson, manufacturers of worsted machinery. His father being in poor health was advised to come to America, which he did, sailing for Philadelphia in 1856. The following year William followed with other members of the family, soon after settling on a farm near Rainsboro, Highland County, Ohio. During the next few years he was employed as a machinist at Harpers Ferry, Va.; Lowell Machine Shop, Lowell, Mass.; Chase & Co., Nashua; and the Grover & Baker Co., Boston. After the Civil War broke out he enlisted in a Pennsylvania company, but on account of his mechanical ability was transferred to the Frankfort Arsenal at Bridesburg, Philadelphia, where he remained throughout the war.

In 1866 Mr. Flather with his brothers moved to Parkersburg, W. Va., and established a shop for the manufacture and

repair of oil-well tools. As this venture did not prove remunerative he returned to Nashua, and with his brothers entered a partnership with the late J. K. Priest who at the time manufactured sewing machines but who later established himself under the title of The American Shearer Co., as a manufacturer of clippers of all kinds. It was the intention of Mr. Priest and the Flather brothers to build lathes also, but the lines were so dissimilar that the partnership was soon dissolved, the Flathers taking over the manufacture of lathes under the firm name of Flather Brothers. Later the name was changed to Flather & Co., the concern consisting of Mr. Flather and his brother Joseph, as active members, and Edward Flather as a silent partner. The high quality of their hollow spindle engine lathes, then somewhat of a novelty, secured them such agents as Hill, Clarke & Co., of Boston, and a certain amount of success. In September 1876 their factory was destroyed by fire, being practically a total loss. With the small amount of insurance received, it was with difficulty that they rebuilt. They had, however, exhibited their lathes at the Centennial Exposition in Philadelphia, which attracted favorable notice from several European manufacturers, resulting in their initial foreign business. After the panic years of the late 70's, their success was firmly established and the business steadily grew in size to its present capacity.

Mr. Flather was also one of the founders of the Mark Flather Planer Co., Flather Foundry Co., and the E. J. Flather Mfg. Co., withdrawing in 1901 from Flather & Co., and the Mark Flather Planer Co. At the time of his death he was president of the Flather Foundry Co., and was actively identified with the E. J. Flather Mfg. Co. He had marked mechanical ability, sound judgment and a faculty of quietly impressing his convictions on his business and other associates. Although a man of retiring disposition, he had an extensive acquaintance in this country and Europe. He was much interested in civic and state affairs, having served as a member of the city government, board of education, state legislature and constitutional convention. He was also a thirty-second degree Mason and prominent in financial circles, being a director of the Indian Head National Bank for twenty-five years. Mr. Flather was actively interested in religious work, being an officer and trustee in several Methodist Episcopal church societies and institutions, including Tilton Seminary. In May of this year he was chosen one of the two lay delegates from New Hampshire to the Methodist Episcopal General Conference at Minneapolis, at which he took an active part. While his early education was interrupted by the migrations of his father's family he was a student all his life, attending evening schools when employed at Philadelphia and devoting much of his leisure time to study and travel, both in this country and Europe. He is survived by his widow; a daughter, and two sons, Ernest J. and Harry E. Flather.

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COMING EVENTS

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

October 16-18.—Annual convention of the National Machine Tool Builders' Association in New York; headquarters, Hotel Astor. James H. Herron, general manager, Cleveland, Ohio.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Brooklyn, N. Y. Circular describing the evening technical courses conducted by the School of Science and Technology at Pratt Institute. These courses offer unusual opportunities to young men who would devote their evenings to studying mechanical drawing and machine design.

Michigan College of Mines, Houghton, Mich. Year book 1911-1912 and announcement of courses for 1912-1913. The year book contains the usual information relating to admission to the college, courses and departments of instruction. It also contains a map of the Portage Lake mining district showing the location of the college in the midst of an active mining territory. Another map shows the mineral district of the upper Michigan peninsula, with the various iron and copper ranges accessible from the college.

NEW BOOKS AND PAMPHLETS

Natural Gas: Its Properties, Its Domestic Use, and Its Measurement by Meters. By P. F. Walker. 38 pages, 6 by 9 inches. 10 illustrations. Published by the University of Kansas, Lawrence, Kans.

This engineering bulletin No. 2, published by the Engineering Experiment Station of the University, contains a report on the subject of natural gas prepared for the Public Utilities Commission of the State of Kansas. The most interesting part of the bulletin is that which relates to the meters for gas, showing the effect of different rates of flow and pressure differences on different makes of meters.

High Explosives. By W. R. Quinan. 210 pages, 6 by 8½ inches. Published by Critchley Parker, Melbourne, Australia. Price, 21 shillings, net.

This book is a treatise on high explosives, mainly from a scientific point of view. The contents of the book are as follows: Historical; Velocity of Detonation; Industrial Explosives; Australian Conditions; Theory of Explosive Energy; Available Energy or Maximum Work; Useful Work; Strength of Explosives; Theories of Explosion; Dissociation; Detonation of Gaseous Mixtures; Dissociation of Explosives—Specific Heats—Boyle's Law at High Densities.

Strength of Materials. By Mansfield Merriman. Sixth Edition. 169 pages, 5 by 7½ inches. Published by John Wiley & Sons, New York. Price $1.

This is one of the standard references on this subject which has become generally known to the profession in its previous edition. In the sixth edition a new chapter on combined stresses has been added. Numerous changes have also been made throughout the text and ninety new review problems added to illustrate the principles treated in each chapter of the book. The number of illustrations has also been increased from forty-eight to fifty-four and the number of articles from seventy-two to ninety-one. It is hoped that the book in its new form may be even more valuable in furthering the progress of technical education than it has been in the past.

Materials and Construction. By James A. Pratt. 196 pages, 5 by 7 inches. Published by P. Blakiston's Son & Co., Philadelphia, Pa. Price 90 cents.

The material in this book has been published with the view of presenting an elementary text for students in technical schools; also as a reference on the more simple problems of construction. Each chapter of the book concludes with problems of a practical nature which not only explain the preceding principles but give the student practice in applying them on the class of problems which he is likely to meet with in engineering practice. One of the notable features of the presentation of material in this book is the method of illustrating. In many cases rough sketches are used, the idea being to familiarize the student with this practice which is followed in many factories, rather than to let him rely entirely upon accurate working drawings.

Manual for Engineers. By Charles E. Ferris. 248 pages, 3 by 5¾ inches. Published by the University of Tennessee, Knoxville. Price 50 cents.

This useful pocketbook which has passed into the seventeenth edition was compiled with the view of interesting the controlling men of the South in technical education as a means of developing the undeveloped resources of their section. Following the pages devoted to the courses of study offered by the University of Tennessee and its equipments and facilities, the book is devoted to the presentation of useful technical data. This section includes mathematical tables, the properties of engineering materials and data pertaining to the transmission and generation of power, to electric wiring, to hydraulics, and to the effect of heat on various materials. Especial attention is called to the excellent presswork and binding which make it attractive to the user.

American Machinist's Grinding Book. By Fred H. Colvin and Frank A. Stanley. 383 pages, 6¼ by 9¼ inches. Published by McGraw-Hill Book Co., New York City. Price $3 net.

The wide application of grinding machines of suitable forms to adapt them for a variety of operations in the manufacture of machinery and of finished metal parts in general, suggested the desirability of presenting material on the subject of grinding in the form of a reference book. The idea in so doing was to present reliable data on the machines, wheels and methods, that is likely to be of interest and service to those engaged in the grinding department. In presenting their subject the authors have dealt separately with the different types of machines in regard to their application in different classes of manufacture. The methods of mounting the wheels and of dressing them are then taken up, and later a number of particular classes of work are dealt with in detail. The authors have drawn upon the columns of different technical papers and also acknowledge assistance received from the manufacturers of grinding machines in securing the data which they have presented.

Shop Arithmetic. By Earle B. Norris and Kenneth G. Smith. 187 pages, 6¼ by 9¼ inches. Published by McGraw-Hill Book Co., New York. Price $1.50.

Many a good mechanic is held back by a lack of mathematical knowledge which makes it necessary for him to "ask the boss," whenever there is any figuring to be done. Such men find it difficult to acquire knowledge that is of much value to them from an ordinary textbook on arithmetic. This is largely due to trouble in applying arithmetical methods to practical problems. In the present book, the mechanic should be saved from this difficulty by the practical problems which follow the discussion in each chapter. Thus the treatment of addition of fractions is followed by exercises in finding the overall dimensions of drawings scaled off in the usual way. A discussion of the micrometer caliper follows the chapter dealing with decimals. Similarly the treatment of methods to find the areas and volumes of different shaped figures is followed by practical problems. The latter section of the book deals with problems occurring in the simpler branches of mechanics. Treated in this way, the mechanic should be able to acquire the knowledge of arithmetic he requires in his work without the aid of an instructor.

Practical Descriptive Geometry. By William Griswold Smith. 208 pages, 6 by 9 inches. 132 illustrations. Published by McGraw-Hill Book Co., New York. Price, $2.

The author of this book, who is assistant professor of descriptive geometry at the Armour Institute of Technology, has endeavored to emphasize the relation which exists between descriptive geometry and drafting. In preparing the book, his aim has been to present the subject in such a manner as to arouse the interest of the student. A large number of exercises are provided, the author believing that a thorough knowledge of the subject is achieved not through much study of the text, but through working exercises. The book is divided into four specific parts, the first dealing with definitions, notations, preliminary theories and exercises; the second, with problems relating to points, lines and planes; the third, with curved lines and surfaces: and the fourth, with perspective and isometric projection. The extent to which the idea of presenting a great number of exercises has been carried can be best understood by noting that there are 860 different problems presented, of which about one-quarter are of such a nature as may be met in actual practical drafting. Most of the exercises are dimensioned so as to require the student to make his drawing according to some predetermined scale.

Machine Design; Hoists, Derricks, Cranes. By Henry D. Hess. 368 pages, 6½ by 9⅝ inches. Published by J. B. Lippincott Co., Philadelphia, Pa. Price $5.

The details comprising the structure of a crane include a large variety of the simpler forms of mechanism met with in many classes of machinery. The stresses which occur in both the frames and machinery are also such that they are readily determined by analytical methods. These conditions have made the presentation of methods used in crane design valuable in two directions: The general reader can acquire accurate data on the design of the common forms of mechanism met with in most classes of machinery. Those seeking specific information on the subject of crane design will also welcome the book as a reliable source of information. The first four chapters are devoted to a discussion of the properties of various materials used in machine construction and to the design of the types of mechanism and structural members applied in cranes of the different forms that are treated. The eight succeeding chapters cover the standard practice followed by the designing departments of leading American crane builders. The book is expected to meet the requirements of the field of machine design covered in technical colleges. Drafting-rooms work-

CONTENTS FOR OCTOBER

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

ing upon general classes of machine design should also find it of value, and the careful attention to detail which has been observed in the preparation of this book should make it favorably received in a variety of designing establishments.

NEW CATALOGUES AND CIRCULARS

Geuder Paeschke & Frey Co., Milwaukee, Wis. Circular of "Cream City" electric butt and spot welding machines.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin No. 1026 entitled "The Youngstown Safety Limit Stop for Direct-current Motors."

R. D. Nuttall Co., Pittsburg, Pa. Supplement to catalogue No. 10 on forged steel motor gears and pinions, containing twenty-nine pages of gear lists.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue E of "Brownhoist" buckets and tubs for handling ore, coal, gravel, sand, earth and other materials.

Vulcan Engineering Sales Co., 2014 Fisher Bldg., Chicago, Ill. Circular of the "Mumford" jolt ramming machines for foundries, enumerating their advantages.

Electro-Dynamic Co., Bayonne, N. J. Data sheets Nos. 3, 4 and 5 on wiring diagrams of interpole motors with Cutler-Hammer compound non-reversible and reversible drum controllers.

Gurney Ball Bearing Co., Jamestown, N. Y. Catalogue of annular ball bearings having full complement of balls, unbroken raceways, and full depth of raceways; also ball thrust bearings of the plain and grooved types.

Foote Bros. Gear & Machine Co., 210-220 N. Carpenter St., Chicago, Ill. Catalogue and price-list No. R on "IXL" speed reducers which are made of the spur gear and worm gear types in a large number of sizes.

C. W. Hunt Co., West New Brighton, N. Y. Catalogue No. 12-8 on manila rope for transmission and hoisting, being a brief treatise for engineers on the manufacture and characteristics of ropes, with formulas, tables and data useful in mill engineering.

Walter B. Snow, 170 Summer St., Boston, Mass. Booklet entitled "Publicity Engineering," outlining the scope of Mr. Snow's activities in engineering publicity work and showing in what radical respects they differ from those of the typical advertising agencies.

General Electric Co., Schenectady, N. Y. Bulletin No. 4995 on direct current switchboards, double polarity, 125, 250 and 600 volts; No. 4996 on alternating current switchboards with oil switches, three-phase, three-wire 240, 480 and 600 volts, 25 to 60 cycles.

Racine Tool & Machine Co., Racine Junction, Wis. Circular illustrating No. 7 high-duty metal cutting machine of the hacksaw type, having capacity from 0 to 12 inches and using blades 17 to 24 inches long. The machine is especially adapted for structural work, being arranged for cutting I-beams, angles, channels, etc.

D. & W. Fuse Co., Providence, R. I. Leaflet describing D. & W. fused switch boxes, being an improved combined switch and fuse box particularly adapted for mill service, etc., inasmuch as it may be locked after the fuses are installed, thereby preventing tampering with the connections and increasing the capacity of the fuses.

National Tube Co., Pittsburg, Pa. Pamphlet entitled "Modern Welded Pipe" illustrating and describing the processes from the mining of the ore through the reduction of the ore to steel, rolling the skelp, lap welding, butt welding, testing, threading, etc. The illustrations are effectively printed in colors, thus showing the metal being worked in the hot state.

Davis-Bournonville Co., 97 West St., New York. Folders Nos. 6 and 7 illustrating examples of locomotive repair work and Davis-Bournonville style C oxy-acetylene welding and cutting torches. The examples of locomotive repair work comprise welding broken frames, firebox cutting and welding, welding firebox cracks, building up thin spots, welding broken driving wheel spokes, etc.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 2480 giving directions for ordering motors for driving machine tools. In addition to giving the characteristics of voltage of direct-current circuits and voltage, phase and frequency of alternating-current circuits, it is necessary also to specify the horsepower and speed. The Westinghouse engineers will advise regarding the power and speed of motors for any type of machine tool.

Standard Mfg. Co., Bridgeport, Conn. Catalogue of gear cutting, milling and slitting machines, consisting of twenty-four pages, 6 by 9 inches, with embossed cover. The catalogue illustrates and describes "Standard" machines Nos. 1, 2, 3 and 5, showing examples of typical commercial work performed; also machines with special attachments adapting them to cutting worms, racks, slitting dials, cylinders, etc. The special work to which these machines can be adapted makes them of unusual interest to manufacturers generally.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. "Besly's Modern Disk Grinding Practice," a treatise on the art of disk grinding, with special reference to reducing cost of flat surfacing in machinery construction, illustrating and describing the extensive line of grinding apparatus made by the company. The growth of the disk grinding art in the past few years and its present importance can be somewhat appreciated by referring to this comprehensive and interesting publication. The first edition containing 40 pages and 23 illustrations was issued two years ago. The present edition contains 111 pages and 103 illustrations

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 3516 listing machine tool motor applications and giving horsepower ratings and classes of motors used. This leaflet covers applications to bolt and nut machinery, boring and turning mills, bulldozers, buffing lathes, drilling and boring machines, cylinder boring machines, pipe threading and cutting-off machines, planing machines, rotary planing machines, hydrostatic wheel presses, punching and shearing machines, punches, shears, shaping machines, bending rolls, cold saws, horizontal boring, drilling and milling machines, multiple spindle drilling machines, emery grinders, grinding machines, gear cutting machines, engine lathes, milling machines, etc.

Hill, Clarke & Co., 125 N. Canal St., Chicago, Ill. "Machinery Bluebook of Modern Machine Tools," describing the line of boring machines, broaching machines, chucks, die heads, drilling machines, grinding machines, gear hobbing machines, key-seating machines, lathes, metal sawing machines, milling machines, patternmaking machines, pipe machines, planing machines, power hammers, presses, shaping machines, screw machines and turret lathes sold by the company. The descriptive matter is unusually complete for a comprehensive catalogue like this, being illustrated with halftones and drawings showing details to which references are made in the text. The book is too costly for general distribution, and will be sent chiefly to manufacturers, or their official representatives, using machine tools.

TRADE NOTES

Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes, are building a large addition to their plant and expect to have it completed January 1, 1913.

Charles H. Sawyer, 7 Lake St., Worcester, Mass., has been appointed New England representative for Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes.

Greenfield Tap & Die Co., Greenfield, Mass., has placed the contract for the erection of four reinforced concrete machine shops with the Aberthaw Construction Co., Boston.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York, furnished about 400,000 square feet of "J-M" asbestos roofing to the Memphis Union Stock Yards, Memphis, Tenn.

Gardner Machine Co., Beloit, Wis., has been made the exclusive distributor and selling agent for the entire output of abrasive disks manufactured by Hermann Behr & Co., Inc., New York.

Pratt & Whitney Co., Hartford, Conn., has opened an office and salesroom for small tools and gages at 336 W. 4th St., Cincinnati, Ohio. The office will be in charge of Mr. C. M. Pond.

Van Dorn & Dutton Co., Cleveland, Ohio, has appointed William E. Reau district sales manager for its portable tool department with headquarters in the Plymouth Bldg., Minneapolis, Minn.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., makers of drop forgings, have opened an office and warehouse at 40 S. Clinton St., Chicago, Ill., where a large stock of drop-forged specialties will be carried.

Kerr Turbine Co., Wellsville, N. Y., has opened an office in Pittsburg to take care of its increasing business in that district. The office will be located at 2137 Oliver Bldg., and will be in charge of Mr. R. M. Rush, formerly with the Drave-Doyle Co.